SUBTROPICAL CULTIVATIONS AND CLIMATES

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A HANDY BOOK FOR PLANTERS, COLONISTS, AND SETTLERS

BY

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EDINBURGH AND LONDON
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PREFACE.

THOUGH much has been written upon the agriculture and produce of the tropics, there is, I believe, no work published in England which deals exclusively with the economic plants of the subtropical and warm-temperate zones. The want of information on the subject has prevented settlers in our subtropical colonies from taking up new cultivations worthy of their careful consideration. The object of this book is to call attention to some of the lesser-known agricultural industries of subtropical regions, which are sources of wealth to the inhabitants, but which are almost unknown to the ordinary class of settlers in our Australian and other colonies.

The present Colonial Exhibition shows what wonderful agricultural resources our colonies possess, and to what perfection many of the industries mentioned in the following pages are carried. These industries are, as a rule, still in their infancy, and may be indefinitely extended. The general tendency of English colonists is to adopt the same branches of agriculture which they

followed in England, and to neglect others which are better adapted for our warmer colonies. In any case, many of the cultivations described in the present volume are well suited for increasing the profits of a colonial farm.

Considerable pains have been taken to point out the climate required by the different plants, and to indicate the approximate degree of temperature which each plant requires. Without some such guide a work of this kind might be misleading, by inducing farmers and horticulturists to attempt cultivations for which they might not have the necessary climate. The subtropical and warm-temperate zones have such a range of climate that strict attention to temperature is absolutely necessary for success. The present volume does not profess to be a complete guide to this; but it supplies information difficult to procure, which, in the hands of an intelligent man, should enable him to draw his own conclusions about suitable "new products" adapted for the temperature, soil, and climate of the country in which he dwells.

While in the colonies, I saw that information on these points was much required. I will give three instances—tea, cinchona, and esparto-grass. The first two of these plants are properly tropical products. That tea will grow in many of our temperate colonies is too well known to require comment; but, as a cultivated plant, tea would ruin any man who attempted to open a tea-garden without abundance of cheap labour, the daily wages of a coolie on the tea estates of Ceylon being from fourpence to eightpence a-day. Were we to judge of the suitability of a country for cinchona cultivation

by the mean annual temperature alone, many places in our Australasian colonies, such as Mongonui, New Zealand, would seem adapted for this delicate tree. But if we look further and examine the mean temperatures for the different months, we should see a wide difference. The variation between the means of the warmest and coldest months at Mongonui is—January 68°.3 and July 53°.9, a difference of 14°.4; whereas, in the cinchona district of Dimbula, Ceylon, the difference is but 3°.70, between 68°.20, the mean of April, and 64°.50, the mean of July. Besides which, we must remember that cinchona, which thrives in the clear rarefied air, bright sunshine, and occasional mists of tropical mountains, where the climate is unusually equable, is unable to bear alternations of seasons the temperatures of which are either too hot or too cold, and conditions of air and light so very different from those of its native forests. Esparto-grass requires to grow for twelve or fifteen years before it is fit to cut, and the enormous resources of North Africa will supply the world with this article for many years to come. These illustrations will show why I do not mention some plants which may at first seem to be omissions. The size of the book might have been considerably increased—other plants might have been mentioned which contribute to the welfare of man in different parts of the world; but the object was not to write a large book, but a small one, the price of which would be within the means of colonial settlers and emigrants.

It is hardly necessary to mention that a great part of this book is compiled from many sources. Some of

these works are expensive, and chiefly devoted to subjects very remote from agriculture; consequently they are not likely to form part of the library of colonial farmers, who have seldom the opportunity or time to consult them in public libraries. A list of the principal works from which information has been derived is appended.

It is to be hoped that the statistics of temperature may prove of use to more people than horticulturists. They may be of service to medical men and invalids who desire information about warmer climates than England for winter quarters or for residence. Emigrants will find them of use in forming an idea of the climate they will experience in their new home. The general reader may also find them interesting. In collecting these temperatures I have received the greatest kindness and assistance from Mr R. H. Scott, Secretary of the Meteorological Office, to whom I am under great obligations.

That this book may be of service to residents in our subtropical colonies, that it may afford useful information to persons who contemplate emigrating to these regions, and that it may help to develop the resources of our colonial possessions, is, I need hardly say, my most sincere wish.

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SUBTROPICAL CULTIVATIONS AND CLIMATES.

INTRODUCTION.

I.—Climate.

The northern hemisphere is divided from the southern by an imaginary line, called the equator, which encircles the earth half-way between the poles. On either side of the equator, at a distance of 23½°, or 1410 geographical miles, are two parallel lines known as tropics—the northern one called the Tropic of Cancer, and the southern one the Tropic of Capricorn. The space between the tropics is the torrid zone. The tropics mark the turning-points of the sun in the ecliptic. The sun being always vertical in some part or other of this space, has more power than in regions farther to the north or south, where its rays strike more obliquely, and consequently with less power—a vertical beam having to pass through less of the dense lower atmosphere than an inclined beam.

The distance from the equator to either pole is divided into ninety degrees of latitude—a degree containing sixty geographical or nautical miles, and sixty-nine and a half statute or common miles. Latitude, therefore, denotes distance north or south of the equator.

Had the surface of the earth consisted of water alone, or only of land of even altitude, the temperature of a country would have been accurately indicated by its latitude. But this not being the case, we find a number of circumstances existing by which the effect of latitude on temperature is modified and altered; and we are obliged to consider many natural causes, some of which are extremely complex and difficult to understand, before we can arrive at any definite conclusions. Nevertheless climate depends mainly upon latitude, as this indicates the obliquity of the solar rays and the distance from the equator, where the greatest mean temperature is found. Though the highest mean temperature for the year is found at the equator, the maximum readings of the thermometer are not obtained in the torrid zone, but at about the thirtieth parallels of latitude during the summer.

Altitude.

The influence of latitude is modified by altitude above the sea-level. In rising above the surface of the earth, we leave a warm body behind us and approach the colder regions of space. As the greater part of the sun's heat reaches the earth, little being absorbed by the atmosphere through which it passes, it follows that the air in immediate contact with the surface of the earth becomes more heated than the upper expanse of atmosphere. The greater the elevation, the less is the atmospheric pressure—consequently the particles of air are not so closely compressed together; but to keep them apart a considerable amount of heat becomes latent, and its effect is therefore not felt.[1] Every three hundred feet of altitude may be roughly calculated to reduce the temperature by 1° F. from what it was at sea-level; hence the changes of temperature experienced in ascending a high mountain. In ascending a mountain, or receding from the equator towards the poles, we meet a gradually decreasing temperature, and in both cases at length arrive at regions of perpetual snow. Humboldt stated that an elevation

[1] Buchan, Handy Book of Meteorology, pp. 127, 128, second edition.

of from 256 to 278 feet produces the same effect on the temperature as if one had retired one degree of latitude from the equator. He found that on the east coast of North America, from Labrador to Boston, the mean temperature increases 1°.58 F. for each degree of latitude one goes south; and proceeding towards the tropics, the temperature increased for each degree of latitude as follows:—

From Boston (42° 20′ N. lat.) to Charleston (32° 43′ N. lat.) 1°.71 F.
From Charleston (32° 43′ N. lat.) to Cuba (23° 10′ N. lat.) 1°.19 F.
From Havana (23° 10′ N. lat.) to Cumana (10° 23′ N. lat.) 0°.36 F.

Proportion of Land to Water.

The extent of the respective surfaces of land and water have a marked effect upon climate. Land has the power of absorbing heat, which is partly conducted down into the soil and partly radiated into the atmosphere. Water absorbs heat more readily than land, but radiates it more slowly, often conveying it to great distances, as in the case of the Gulf Stream, which absorbs its heat in the Gulf of Mexico and radiates it on the British coast. The sea is thus a reservoir for heat; and from this cause islands have milder and more equable climates than continents, where the extremes of heat and cold are greater. For the same reason, owing to the greater surface of sea than land, the southern hemisphere possesses a milder and more insular climate than the northern. The proportion of land and water in the two hemispheres is about:—

Northern hemisphere,	Land,	38,000,000	square miles.
"	Water,	60,500,000	"
Southern hemisphere,	Land,	13,500,000	"
"	Water,	85,000,000 [1]	"

The distribution of heat over the globe is easily seen by referring to charts of isothermal lines, or lines of equal heat, which connect those places having the same mean temperature. If we turn to these charts, and follow the course of the lines for January and July, we see how evenly the lines run in the southern hemisphere when compared with the course

[1] Page, Physical Geography.

of corresponding lines in the northern hemisphere. From these we learn that the climate of the southern hemisphere is more equable or "insular" than the climate of the northern hemisphere, which is more subject to extremes of heat and cold, or "continental," than the former. We also learn that corresponding extra-tropical latitudes in the two hemispheres have widely different climates.

Ocean-Currents.

Climate is greatly influenced by ocean-currents. Those flowing from a warm to a colder region raise the temperature, and those which flow from a cold to a warmer locality reduce it. There are three principal sorts of currents: 1. The constant, caused chiefly by the varying density of sea-water, arising from difference in temperature and saltness; 2. Periodical currents, occasioned by tides and tropical winds which blow at regular seasons; 3. Variable currents, due to local circumstances. Of these the constant are the most important, and are produced by the heat of the torrid zone, which raises the temperature of the sea and occasions great evaporation of fresh water from the salt water. The latter becoming denser from its increased saltness, sinks, and is replaced by a steady flow of water, which in its turn is subjected to the same process. Again, the water of the arctic and antarctic seas being about 50° colder than the water of the equatorial seas, is consequently heavier; and where there are waters of different densities, the lighter will ascend and the heavier descend: thus the warmer and lighter water from the tropical seas flows towards the poles, being replaced by an under current of colder water from the polar seas. A continual interchange of water is thus taking place,—though, owing to intervening areas of land and other causes, numerous currents and counter-currents are produced which become exceedingly complicated.

The temperatures of the west of Europe, east of South America, the east of Africa, and south of Asia, are raised by ocean-currents, which, on the other hand, lower the temperatures of both coasts of North America, the west coast of South

America, the west coast of Africa, the east coast of Asia, and the south coast of Australia.[1]

Winds.

Wind is air set in motion by differences of atmospheric pressure, caused by variations in the temperature or humidity of the air. Currents of air are thereby produced—the colder and heavier air forming under currents, equilibrium being restored by upper currents of warmer and lighter air.

The effect of wind upon climate depends upon the difference existing between the temperatures of the regions in which they spring and that upon which they strike. Thus winds coming from warm regions are mild, and those from cold regions are chilling. Winds from the sea are uniform, and not so subject to the extremes of heat and cold which characterise the winds which blow over continents, the temperature of the ocean being more equable than that of the land. Sea-breezes are more or less charged with moisture, which imparts humidity to the atmosphere and checks both solar and terrestrial radiation, giving mild winters and cool summers to insular countries, producing an opposite effect to the hot summers and cold winters occasioned by dry continental winds.

There are three great classes of winds:—

1. Constant, such as the trade-winds, caused by the air of the torrid zone becoming heated and ascending, while the colder air on either side pours in to supply the deficiency—this motion being modified by the earth's rotation.
2. Periodical winds, such as the monsoons, which blow in certain seasons of the year in and about the tropics with wonderful regularity.
3. Variable winds, confined chiefly to extra-tropical countries, and caused by local circumstances, such as the distribution of land and water, vegetation, mountains, plains, &c.

[1] Buchan, Handy Book of Meteorology.

Rain.

The warmer and drier the air, the greater is its power to absorb moisture; but the power of retaining this moisture is reduced by contact with other currents of air of very slightly different temperature, or by the colder surface of the land, and precipitation follows. The great evaporation which takes place in tropical seas results in large quantities of water being absorbed by the atmosphere; the warm surcharged air is forced upwards into the higher atmosphere by currents of air which are drier, colder, and heavier, where part of its moisture is condensed, falling in the form of rain. Where constant winds of even temperature prevail, as in the tropics, rain falls less frequently than it does in temperate zones, where the winds are variable and constantly changing; but owing to the greater capacity for absorbing moisture possessed by hot air, tropical rains are usually very heavy. In 1879 the rainfall at Colombo was 84.32 inches, which fell in 128 days; the same year the rainfall at London was 33.83 inches, which fell in 181 days; and in Tasmania 21.16 inches of rain fell in 213 days. As a rule, we find that whenever the temperature of the air is reduced, rain falls. Thus in Ceylon, when the rainfall at Colombo was 86.13 inches at sea-level—in the district of Dimbula, at 4600 feet elevation, 117.39 inches of rain fell, the increase being due to the colder atmosphere and the effect of the surrounding hills.

The quantity of rain which falls on some countries is extraordinary. Thirty inches have been recorded as falling on each of five successive days on the Khassia Hills.[1] The river-flats of Bengal, and basin of the Orinoco River in South America, have annual rainfalls of 600 inches. But while some places are thus deluged with rain, others have little or no rainfall. Arabia, the Sahara in Africa, the coast of Peru, and the Mongolian desert, are almost rainless, and consequently nearly destitute of vegetation.

[1] Buchan.

Dew.

At night, when the heat of the sun is no longer felt, the earth radiates its heat into space, and cools rapidly. If the sky is cloudy, part of this heat is reflected back upon the earth; but if the night is clear and still, the earth cools sufficiently to condense the moisture of the atmosphere, which is deposited on substances having a lower temperature than that of the air. If the "dew-point," or temperature at which condensation takes place, is below the freezing-point, the dew is deposited in the form of hoar-frost. From the hot moist atmosphere of tropical countries dew is abundantly condensed, plant-life being often dependent upon it for support in periods of drought. In deserts, though radiation is great, little dew is deposited, owing to the extreme dryness of the atmosphere.

Snow.

When the temperature of the atmosphere falls to the freezing-point, the moisture descends in the form of snow. Snow being a bad conductor of heat, prevents it from radiating from the soil and escaping into the air. The temperature of the ground under the snow may thus be as much as 40° above that of the atmosphere.

The line of perpetual snow depends upon latitude. At the equator it occurs at 16,000 feet elevation; in latitude 20°, at 14,000 feet; thence, for every 5° of latitude farther from the equator, the snow-line descends about 1000 feet, till we find a region of perpetual snow at 80° N. latitude. This is only approximate, as local causes may alter it. The snow-line at any place may be roughly calculated by taking the mean annual temperature at sea-level, and multiplying the difference between that temperature and 32° F. by 300.[1]

Mountains.

Mountain-ranges have a marked effect upon climate by intercepting cold winds: these, being forced upwards, part with

[1] Parkes, Practical Hygiene.

the moisture they contain, which falls as rain on the side of the mountains exposed to their force. The sheltered side of the mountains has therefore a warmer and drier climate than the exposed side; but owing to the absence of aqueous vapour, the country on the lee side is exposed to both terrestrial and solar radiation, and though the summers are hotter, the winters are colder. A noticeable instance of this occurs at Hokatika, New Zealand, on the western side of the Southern Alps, where the rainfall is 112 inches, the maximum heat experienced 77°.9, and the minimum cold 27°.9. At Christchurch, on the opposite side of the island, the rainfall is 25.77 inches, the maximum heat 89°.6, and the minimum cold 21°.3.

The side of a mountain-slope exposed to the morning sun is considerably warmer than a slope which receives the afternoon sun, which is decreasing in power. It is too well known to require comment, that a favourable exposure is of great advantage to cultivation. An instance of this occurs in the situation of the Sydney Botanical Gardens, where one sees tropical plants growing which, in ordinary situations in the neighbourhood, would not succeed. The temperature of the gardens, owing to the favourable exposure and sheltered position, is said to be 4° above that of the adjacent country.

Surface of the Earth.

The heat of the sun which strikes the surface of the earth only penetrates to a depth of four feet. Dense bodies are the best conductors of heat, and loose porous bodies the worst. Dark-coloured bodies absorb heat, light-coloured bodies reflect it. Therefore compact soils, such as clays, allow heat to penetrate to a greater depth than loose sandy soils, into which air passes freely, absorbing part of the heat they receive; and soils of a black, brown, or red colour absorb more heat than grey, yellow, or white soils, which reflect most of their heat, retaining little except at the level of the ground. Light porous soils are subject to higher temperatures, and a greater degree of frost near their surfaces, than dense heavy soils; but frost

penetrates farther into dense soils, while it only affects light soils superficially.

Schübler found that, when the thermometer was 77° in the shade, the temperature of white sand was 110°, ordinary sand 112½°, black sand 123½°. Sand being a bad conductor of heat, the temperature of the atmosphere in sandy places is greatly raised, the heat of the sand being almost entirely in contact with the air. This accounts for the great heat of dry sandy deserts, where there is no vegetation or moisture to modify the temperature.

The temperature of the soil varies according to its humidity. Dry land absorbs heat more quickly and parts with it more slowly than wet land; the latter is also more subject to evaporation, the effect of which is to lower the temperature in the vicinity of where it takes place: hence drained land is warmer than undrained, the summer temperature being occasionally 3° more. If this is the case with agricultural land in England, how much greater must it be in new countries where there are large extents of swamp!

Vegetation lowers the temperature of the soil by receiving and absorbing the solar heat; but owing to evaporation from the leaves, the temperature of the plant is lower than the temperature of the soil would be were both equally exposed. Besides, owing to the volatile nature of heated air, a considerable part of it is carried away, as it cannot remain on the surface of the plant, and its place is supplied by colder air. Similarly to other bodies, trees are heated and cooled by solar and nocturnal radiation; but owing to their slow conducting power, the times of their maximum and minimum temperature do not occur till some hours after the same phases of the temperature of the air: hence forests make the nights warmer and the days cooler, and the effect of vegetation is to equalise the temperature of the whole day.[1]

As forests allow comparatively little circulation of the air, the vapours of the soil accumulate among the trees, thus

[1] Buchan.

diminishing the evaporation but increasing the humidity of climates within their influence.[1] They further increase the humidity by absorbing a great deal of rain; and from their lower temperature to that of the surrounding country, they condense the moisture of winds from the sea. The latter fact is observable from the tendency of mists to hang about forests, especially towards the middle of the day: the temperature of the trees being lower than that of the mist, causes condensation. On high hills in the tropics this is particularly noticeable, as is the tempering influence of trees upon the solar heat.

M. Becqueral observes that the evaporation of leaves, being condensed, causes humidity and cools the soil. He believes the dry climate of Asia Minor arises from deforestation. He further points out that extensive forest-clearings lessen the volume of rivers, either by diminishing the rainfall or increasing evaporation; that the cultivation of a dry and treeless region lessens the supply of spring-water; that forests shade springs and protect the water; that forests increase humidity, and the roots of the trees render the soil more pervious to rain-water. The clearing of hills has a marked effect upon the sources of rivers and the supply of water. Where the area of cultivated land is unaltered, the water-supply is undiminished.[2]

But perhaps the greatest effect of forests on climate is local, being the shelter they afford against cold ungenial winds. If garden walls increase the temperature of the enclosed space equal to 7° of latitude nearer the equator, a protecting belt of forest round a field should have almost as much effect. The wholesale denudation of forests completely alters the climate of countries where it has been allowed to take place. The effect is not always the same. The climate may become drier, even arid; it may let in cold winds, stunting vegetation for years to come. In Australia it is doubted whether the destruction of forests has any effect whatever upon the rainfall, contrary to the opinions of European and American observers.

[1] Buchan.
[2] Forests on Climate—Journal of the Scottish Meteorological Society.

Light.

Light is an important consideration in agricultural meteorology. Plant-life is dependent upon the action of light for assimilation, or the production of organic matter from the inorganic elements of the air and soil. The stronger the light, the greater is the power of assimilation. Without light there is no fructification. "Cultivated plants cannot ripen their seed without the direct light of the sun; and the longer they are deprived of it, the smaller the quantity which they will mature."[1] The respiration of plants is assisted by the action of light. M. Albert Levy says: "It is well known that the ordinary observations of temperature have only a very general relation to the growth of plants, which latter depends upon the direct action of the sun's rays. This is especially true of the ripening of grain, fruits, and vegetables; and some means of recording the direct action of the sun's rays has long been a desideratum to the student of the relations between agriculture and meteorology."[2]

At high elevations on mountains, solar light is particularly intense though the temperature is low. This causes the difficulty in cultivating alpine plants, which require strong light but a low temperature.

Humboldt said in his 'Cosmos': "In countries where the myrtle grows wild, and the snow does not continue on the ground during winter, the temperature of summer and autumn is barely sufficient to ripen apples thoroughly; and if the vine (to produce drinkable wine) avoids islands, and in almost all cases proximity to coasts, the reason is by no means exclusively the low summer temperature of such situations, shown by the thermometer suspended in the shade,—it is also to be sought in a difference which has been hitherto but little considered, although known to be most actively influential in other classes of phenomena—I mean the difference between

[1] De Gasparin.

[2] Quoted from the Report of the Chief Signal Officer for the U.S., 1881.

direct and diffused light, or that which prevails when the sky is clear and when it is veiled by cloud or mist."

At the present day comparatively little is known of the action of light on plants. The subject is exceedingly complex. When the sky is clear, and the light of the sun shines directly on a fruit-tree, we know that the fruit will be better and sweeter than when the light is diffused or reaches the earth through cloud or mist. This is particularly noticeable in grapes, the free acids of which, at maturity, are in proportion to the weather experienced at the time of vintage—the effect of bright sunshine being to diminish the acid of the grape.

Without light, plants would not be able to perform many of the functions necessary to them. Light is chiefly needed by the leaves and stems; and so necessary is it, that we often see how plants, growing in too shaded a situation, invariably incline towards the quarter from which they obtain the greatest supply. Yet some plants require it in a less degree than others. Ferns prefer a sheltered situation. Cacao requires a considerable degree of shade. In the most shaded depths of the densest jungle in the mountains of Ceylon, we find a lovely little ground-orchid (*Anœctochilus*), a tiny plant which seems to dread light. The Singalese have named it "Wanah-rajah," or "King of the forest"; and I have never seen anything more lovely than its two rich sap-green or purplish leaves, traversed by delicate golden or silvery veins.

II.—Geographical Distribution of Plants.

Every species of plant can only flourish within certain limits, fixed by temperature and humidity. These limits may be wider or narrower, according to the hardiness of the plant. Some plants being hardier than others, stand greater extremes of heat and cold, drought and wet, and consequently have larger geographical bounds; but every plant has some confine beyond which it ceases to exist. The only proof of

a plant being thoroughly suited for a new country or climate is when it continues to perform all its functions properly, and is able to fully ripen its seed. It is quite possible for a plant lately introduced into a country to produce partially ripened fruit regularly every year, and even in an exceptionally hot season to succeed in ripening its fruit, showing that it is removed but a short distance beyond its geographical bounds, or beyond the climatic influences necessary for it; but though such a plant is interesting as a specimen, it would not do for cultivators to risk growing a plant whose annual return was so uncertain. We must remember that plant-life is far more delicate than animal-life, and more dependent upon certain conditions of climate and soil.

Annual plants, such as the cereals, which grow fast and ripen their seed in the short space of a cold-temperate or sub-arctic summer, seem to have their farthest limits from the equator fixed by the mean temperature of the summer months: the season, though short, is hot, and has its heat concentrated in a period of short duration. Thus maize ripens near Montreal in Canada, where the mean annual temperature is 44°.3, or 2° lower than the mean annual temperature of Stromness (Orkney); but the mean temperature of the Montreal summer months is 69°.5, while the mean of the Stromness summer months is only 54°.42. Bristol, which has the warmest summer in England, has a mean temperature at that season of 64°.33. We can therefore understand, that owing to the hot summer at Montreal, maize, a plant injured by cold nights and killed by frost, can be ripened sufficiently well to be a farm crop of considerable importance; while it could only be ripened under most exceptional circumstances as a garden plant at Bristol; and at Stromness, despite the mean temperature of the year being above that of Montreal, it would hardly grow at all. At Stromness, where the mean annual temperature is 46°.34, and the latitude 59° N., a limited amount of barley is grown, which ripens with difficulty, and wheat does not ripen, as it requires a summer

temperature of at least 57°; but at Christiania (latitude 60° N.), where the mean annual temperature is 41°.5, wheat ripens, the mean summer temperature being 60°.

Barley, the hardiest of all the cereals, requires a mean summer temperature of from 46° to 49°, according as the climate is wet or dry. It is the only crop grown in the Faroe Islands (lat. 62° N.), but does not always ripen there; but in Finland (lat. 70° N.) it ripens in six weeks from sowing the seed.

We thus see that the ripening of the common cereals depends upon their receiving certain degrees of heat, according to their species, in a limited period of summer; but were the same amount of heat to be diffused over a slightly longer duration of time, the same result would not be effected, and they would not ripen, as the summer temperature would then be insufficient. This is the reason why barley does not always ripen in the Faroe Islands, though it ripens in Finland 8° farther north. From what has been stated, we may also deduce another conclusion—viz., that a plant requires more heat to ripen it in an insular climate than it does in a continental climate, both being situated in the same parallel of latitude. The reason being that the island temperature is too equable, the atmosphere too humid, and solar radiation less, the plant consequently does not receive enough heat to force it into bearing ripe fruit, but will only vegetate, producing leaves and sterile flowers, or at most abortive fruit. In cold countries, where the summer is short, the days are unusually long, which accounts for the rapid growth vegetation makes in sub-arctic summers, where the heat and light are so remarkably continuous.

In all plants vegetation is not forced in the same proportion by an equal elevation of temperature, some plants requiring a longer continuance of heat than others. One fact we must bear in mind,—every plant must receive a certain amount of heat within a particular period of time, to enable it to perform its functions properly. Boussingault's theory stated:

"The duration of vegetation appears to be in the inverse ratio of the mean temperature; so that if we multiply the number of days during which a given plant grows in different climates by the mean temperature of each, we obtain numbers that are nearly equal. The result is not only remarkable, in so far as it seems to indicate that upon every parallel of latitude, at all elevations above the sea-level, the same plant receives in the course of its existence an equal quantity of heat; but it may find its direct application by enabling us to foresee the possibility of acclimatising a vegetable in a country the mean temperature of the several months of which is known." The mean temperature of the respective months during which the plant is growing and ripening must be taken. Boussingault constructed the following table:—

	Latitude.	Duration of the days of cultivation.	Mean temperature during the cultivation.	Product of the days by the temperature.
Cultivation of autumn wheat.				
Alsace, ...	48° 48″	137	15° Cent.	2055
Alais, ...	44 7	146	14 .4	2092
Kingston, ...	41 50	122	17 .2	2098
Cultivation of summer wheat.				
Alsace, ...	48 48	131	15 .8	2069
Kingston, ...	41 50	106	20	2120
Cincinnati, ...	39 6	137	15 .7	2151
Truxillo, ...	9 00	100	22 .3	2208
Quinchuqui, ...	0 14	181	14	2230
Cultivation of winter barley.				
Alsace, ...	48 48	122	14	1708
Alais, ...	44 7	137	13 .1	1795
Kingston, ...	41 50	92	19	1738
Santa Fé, ...	4 35	122	14 .7	1793

From the amount of heat required by any plant to bring it to maturity, we can understand how in low latitudes the same quantity will be received in a shorter period than in latitudes farther from the equator, and the plant will therefore run its course in less time. For this reason some warm countries are able to have two crops in the year, the winter one of which may thus receive the same total amount of heat during these

months that it would receive during the summer months of a temperate climate. Wheat is a summer crop in Europe, but a winter crop in India, being cut some three months after sowing. However, it must be borne in mind that elevation would decrease the temperature received by a plant in the tropics, much as a change of latitude would do.

Perennial plants probably owe their geographical position to the extremes of temperature experienced in the summer and winter months. The perennials of the temperate zones do not thrive in the heat of the tropics, which, among other effects, deranges their laws of growth. The vine does not thrive south of latitude 35° N., as it then does not experience the cold of winter necessary to check its growth, and consequently grows throughout the year, the clusters presenting the curious anomaly of both ripe and green fruit, and even flowers, growing on the same stalk. The perennials of warmer regions have their physiological functions upset by being carried beyond the limits of heat necessary for them; and although for a short distance beyond their limits they may continue to produce leaves, yet they will not fructify, and if the distance is increased, they soon succumb to the frost and cold of winter. Decandolle formed several theories on this subject:—

1. The power of each entire plant, or part of a plant, to resist extremes of temperature, bears an inverse ratio to the quantity of water it contains.
2. The power of resisting cold is in a direct ratio to the viscidity of the juices which a plant contains; or the thicker the fluid sap of the plant is, the better will it resist cold.
3. The resistance to cold in a plant is in the inverse ratio to the mobility of its juices. Those plants will therefore stand most cold whose sap flows slowly or ceases to flow in cold weather.
4. The larger the diameter of the vessels and cells in a plant, the more liable it is to injury from frost.
5. The power of resisting extremes of temperature bears a

direct ratio to the quantity of air entangled between the parts of the vegetable tissue.[1]

As a rule, excessive heat is less fatal to the plants of a temperate zone than excessive cold is to those of a warm zone. In the former case, the plant has a chance of maturing in the cold season; in the latter, frost is almost certain to kill it. Many of the annual plants of England become perennial in milder climates where they are not subjected to the rigour of an English winter. The action of frost is to make the fluid contents of the leaf-cells escape and freeze outside of the cells. If the fluid freezes inside the cells, they burst, and the leaves blacken, wither, and die; but in the case of the fluid merely escaping, it is possible for it to be again absorbed through the walls of the cells, when vitality is resumed. The action of heat is to cause excessive transpiration, and if the supply of moisture is deficient, the leaves soon wither. When the heat is too intense for the nature of the plant, the protoplasm is destroyed and the leaf dies. In considering the temperature required by different plants, we must know the monthly isotherms of temperature of the country to which they belong. We must pay attention to the maximum and minimum degrees of solar heat, rainfall, humidity, and other peculiarities of climate. "In determining the limits of distribution in the vegetable kingdom, we must know the mean monthly and the mean daily temperature during those periods when vegetation is active. We must ascertain the number of days which a plant requires to produce successively its leaves, flowers, and fruit, and we must estimate the mean temperature during that period. The conditions which define the limits of a plant require that we should know at what degree of temperature its vegetation begins and ends; and further, the sum of the mean temperature during that time."[2] We must consider not only the rainfall, but the moisture of the atmosphere.

[1] Daubeny, Lectures on Climate in regard to Vegetable Life.
[2] Balfour, Class-Book of Botany.

Having satisfied ourselves as to the climatic requirements of the plant we are studying, we must remark the nature of the soil in which it grows, and whether it grows in the open, or shaded by other plants or trees.

The division of the globe into zones of temperature is an important matter to consider. We first find the intertropical zone distinguished by constant heat, excessive moisture, and luxuriant vegetation. Within the tropics there is comparatively little variation of temperature. If we compare the mean monthly temperatures at Kingston, Jamaica; Zanzibar; and Bua, Fiji, we will see how slight the variation is:—

	Lat.	Jan.	Feb.	Mar.	Apr.	May.	June	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
		°	°	°	°	°	°	°	°	°	°	°	°	°
Kingston,	18°1′N.	76.4	75.7	76.2	77.5	77.7	80.0	81.5	80.9	81.5	79.2	77.4	77.2	78.4
Zanzibar,	5 43 S.	82.6	82.9	83.2	81.5	80.0	78.6	77.2	77.4	78.1	79.4	80.9	82.2	80.3
Bua, .	16 38 S.	81.2	80.5	79.2	79.9	79.3	77.1	76.5	77.9	79.7	79.9	81.1	80.8	79.4

The subtropical zone is marked, on continents, by summers of more than tropical heat, while the rest of the year is more or less temperate. The rainfall is less than in the tropical zone, and more irregular in its distribution. A considerable part of this zone consists of arid deserts, where rain seldom falls. The winter of this zone is often rather a rainy season than a season of cold. The flora of this zone has been estimated at 40,000 species, or two-fifths of the known plants of the world. The common cereals, wheat and barley, are cultivated, and the zone is marked by many fruits and plants of great value to man.

The warm-temperate zone is a modification of the subtropical. The winters are colder, and give a decided check to vegetation. The summers are not so hot. Altogether this is probably the zone where man thrives best. Rain generally falls plentifully, the distribution being caused by atmospheric depression.

The cool-temperate zone has a cold winter, which makes

the trees shed their leaves. The four seasons of the year become distinctly marked. Grasses abound, and this zone is the limit of wheat cultivation.

The subarctic zone is characterised by a very limited flora, consisting of conifers, willows, heath, grasses, &c., which decrease on approaching the arctic circle, within which only some 800 species of plants are found.

It is necessary to point out that these divisions of the earth into zones, though useful for comparison, are in reality only rough approximations. Climate is affected by so many natural causes that it would be impossible to divide it into belts of perfectly similar climate. Grisebach divided it into twenty-four phyto-geographical regions. Schouw adopted twenty-five regions. Neither of these systems is, however, absolutely reliable, though they are interesting, and the results of much study. Careful study of the isothermal lines is probably the best help to understand the distribution of heat with regard to plant-life. Mayen divided the globe into the following zones of plant-life :—

1. Equatorial, comprising the belt for 15° of latitude on either side of the equator, having a mean temperature of from 79° to 86°. This is the home of palms, bananas, gingers, orchids, &c.
2. Tropical, from 15° to 23½° lat. Mean temperature, 79° to 73½°. Climate generally humid and hot. Region of tree-ferns, figs, proteaceæ, eucalypti, acaciæ, &c.
3. Subtropical, from 23½° to 34° lat. Mean temperature, 70° to 64½°. Distinguished by myrtles, magnolias, laurels, camellias, and heaths.
4. Warm-temperate, from 34° to 45° lat. Mean temperature, 64° to 54°. Here we find olives, ilex, evergreens, vines.
5. Cold-temperate, from 45° to 58° lat. Mean temperature, 54° to 43°. Marked by deciduous trees.
6. Subarctic, from 58° to 66° lat. Mean temperature, 43° to 39°. Conifers abound.

7. Arctic, from latitude 66° to 72°.
8. Polar.

Mr Page, in his 'Physical Geography,' gives a most useful division :—

1. Equatorial, bounded by the isotherm of 79°.
2. Tropical, " 73½°.
3. Subtropical, " 63°.
4. Warmer-temperate, " 53½°.
5. Colder-temperate, " 42½°.
6. Subarctic, " 39°.
7. Arctic.
8. Polar.

When we regard the vegetation of high tropical mountains, we find these zones represented thus :—

Equatorial,	up to 2,000 feet elevation.
Tropical,	from 2,000 to 4,000 feet.
Subtropical,	" 4,000 " 6,000 "
Warm-temperate,	" 6,000 " 8,500 "
Cold-temperate,	" 8,500 " 11,000 "
Subarctic,	" 11,000 " 13,000 "

Professor Balfour, in his 'Handbook of Botany,' gives a valuable table of mean temperatures at different heights, and at different degrees of latitude :—

Elevation above sea-level.	Cordilleras, lat. 10° N., to 10° S., mean annual temperature.	Mountains of Mexico, lat. 17° to 21° N., mean annual temperature.	Mountains of Europe, lat. 45° to 47° N., mean annual temperature.
0	81°.5	78°.8	53°.6
3,197	71 .4	67 .6	41 .0
6,394	64 .4	64 .4	31 .6
9,591	57 .7	57 .2	23
12,789	44 .6	45 .5	...
15,985	37 .7	33 .8	...

Above these elevations there is perpetual snow.

III.—Acclimatisation of Plants.

Mr A. Henfrey said, "Agriculture bears a close relation to civilisation." When a nation begins to emerge from the most primitive condition, one of the first signs of increasing development is the cultivation of the ground. The few wild plants which they were wont to hunt for when utter savages, they now find more convenient to grow close to their abodes. As their social progress increases, more attention is paid to agriculture; they discover the uses of fresh plants as medicines, food, or in their rude manufactures. It no longer does to depend upon an uncertain supply from the forests; they must have the plants ready to hand when they want them, and they accordingly plant them in the most convenient situations. As they grow the plants, they observe that, by tending them and tilling the soil, the return is improved in both quantity and quality: the first step in agriculture has been made, and the race rises in the social scale. At this period, plants are only grown to supply pressing necessities; but as civilisation sets in, plants are grown for luxuries consequent upon a greater degree of refinement. As intercourse with other nations increases, they learn to bring plants from neighbouring countries, and thereby develop the resources of their own land.

Thus the acclimatisation of plants was commenced in ages so remote that the origin of many of our most useful plants and vegetables is unknown. At the present day we find the same exertions being made as the uses and demand for vegetable products is always increasing.

Though the native country of a plant, where its growth is spontaneous, may be regarded as the country most naturally suited for its existence, it does not necessarily follow that this is the case when the plant is brought under cultivation. Then a number of other circumstances must be considered, the chief of which are the cost and supply of the labour required in cultivation, and the proximity of markets for the disposal of the

raw material. It may happen that in the native country of the plant labour is scarce and dear; roads may be wanting by which to convey produce to the sea; or there may not be a sufficiently large area of land to grow the amount required. In some other country, however, labour may be plentiful and cheap, and there may be an almost unlimited extent of conveniently situated waste land. It therefore follows that it is cheaper to introduce and cultivate the plant in such a country rather than to collect it in its native habitat; or, where the actual area of land is insufficient, to dispense with its use.

We have an instance of the former case in the introduction of cinchona into India, Ceylon, and Jamaica by Mr Clements Markham—to whom the world owes a deep debt of gratitude—which has greatly increased the supply and lessened the price of this most valuable medicine, and conferred an inestimable benefit on the fever-stricken inhabitants of tropical countries. In the other case, where the area of land is itself insufficient to give the amount of produce required, we can take as an instance the export of seed-wheat from England to her different possessions—America, Australia, India, &c.

When we consider the vegetable food-supplies of any civilised nation, we cannot help remarking that all are indebted to the acclimatisation of plants for their most common means of subsistence.

If we take the luxuries of life, we find this is even more remarkable. Coffee, originally a native of Abyssinia, is now chiefly imported from Brazil, Java, Ceylon, and the West Indies. The sugar-cane was introduced into the West Indies by the Spaniards in the fifteenth century; and half the cane-sugar consumed in the world continues to come from these islands and the neighbouring mainland. Ginger was introduced into Jamaica from India by Francisco de Mendiza. The mango, which now grows so abundantly in Jamaica, was brought from India by Captain Marshall in 1782. Guinea-grass was originally introduced in 1745 into the same island from Africa as bird-seed, some of which, being accidentally

dropped, grew, and the grass now covers 120,000 acres. Rice, one of the staple articles of food in the Southern States of North America, was introduced by a vessel from Madagascar which called at Carolina. The captain gave a little seed-rice to a gentleman named Woodward. From this Mr Woodward raised a good crop, which, not knowing how to prepare it, was distributed among his neighbours, and by the experiments and thought of many individuals the cultivation was raised to its present high standard.

But the benefits were not alone granted by the Old World to the New. From America came maize, the potato, cassava, tobacco, india-rubber, mahogany, cinchona, pimento, and cacao. The diversity of climate and great vegetable luxuriance of the New World could not fail to produce many plants of the greatest use and importance to mankind.

Tea was introduced from China into Assam, where it hybridised with a local variety, and the result was a superior plant to either the imported or indigenous. The sugar-cane is supposed to have travelled westward from Cochin China. The vine, cherry, plum, and currant appear to have originated in the west of Asia, south of the Caspian Sea. Oranges seem to have come from Further India, or China, to Eastern Europe, whence they spread westwards, and were introduced into the New World by the Spaniards. But perhaps the most wonderful case of acclimatisation was the black mulberry. About the year 527 A.D. the Emperor Justinian sent two monks of the Order of St Basil to the north of India, from whence, at the risk of their lives, they introduced the eggs of the silkworm and seeds of the mulberry into Europe, and laid the foundation of an immense industry from the contents of two hollow bamboo walking-sticks.

In fact, when we look at the origin of the most valuable economic plants, we cannot help noticing that while one part of the world lent a plant to another, it generally replaced it by one from some other quarter; and that from the Old World to the New, and from the New to the Old, there has been a regular

system of exchange and borrowing in plants for both use and ornament. And there is hardly any country in the universe which is not under obligations to the trouble and forethought of some individual who unselfishly sacrificed a little spare time and labour for the benefit of his fellow-men. There are even instances of devotion to the plants under their care exhibited by such philanthropic men. A beautiful story is told of the introduction of coffee into the French colony of Hayti. In 1714, Louis XIV. obtained a plant of coffee from the Botanic Gardens at Amsterdam. This was intrusted to the captain of a ship bound for Hayti. On the voyage the supply of water ran short, and the heroic captain shared his scanty allowance with the plant intrusted to him. From this plant is said to be descended all the coffee in the West Indies, Central America, and probably of Brazil also—the value of the produce of which must be worth many million pounds sterling a-year!

Occasionally the results in acclimatisation are not so fortunate. Ageratum is a plant belonging to the genus Composites, with an azure-blue flower, commonly seen in English gardens. The wife of a former Governor of Ceylon is said to have introduced it into her garden, and from thence it spread over the island as a most troublesome weed. It has been calculated that it cost the planters over £250,000 yearly to keep it down in the coffee plantations. The thistle is said to have been introduced into New Zealand by a patriotic Scotsman, but it was probably brought along with grass-seed.

In removing a plant from one country to another, the constitution of the plant usually receives more or less of a shock. In their natural state, plants seldom range so far beyond their geographical bounds that they are destroyed by the severity of the climate alone. An abnormal season, however, might destroy those at the extreme limits of their growth; but this would not be so likely to occur to plants growing in favourable situations. Mr Darwin remarks: "When a plant is placed in a new country, though the climate may be exactly the same as in its

former home, yet the conditions of its life will be changed in an essential manner. If we wished to increase its average numbers in its new home, we would have to modify it in a different way to what we should have to do in its native country, for we would have to give it some advantage over a different set of competitors or enemies."[1] Mr Darwin further points out how plants may be hardened, or adapted, to a climate by collecting and resowing the seed of those plants which arrive at maturity. Each successive generation of the plant will prove hardier; and in this way he believes that the Jerusalem artichoke and kidney-bean might be sufficiently hardened to ripen their seeds in England.

When a new plant is introduced into a country, it is necessary to observe carefully the effect of the new climate upon it. The results of different soils and situations should be carefully noted, and a record kept of the growth and progress of the plant at its different stages. The seasons of blossom and fruit must be observed, and especially the time it takes the fruit to ripen. It is only by devoting time and interest to the plant that success in naturalising it can be expected.

In the preceding section it has been shown that the primary requirement of any plant is a certain degree of temperature. It has also been observed that, to bring the fruit of any plant to perfection, this temperature must be given during certain seasons. It should therefore be ascertained, before attempting to introduce a new cultivation into any country, whether the temperature of the new home corresponds with that which the plant received in the part of the world from which it is proposed to introduce it. Even when this is satisfactory, there are still questions as to rainfall, light, soil, situation, &c., which must be considered.

The table of the mean monthly temperatures and annual rainfalls of different parts of the world (see Appendix) will be found useful in comparing the climates of remote countries, and gives a clue to the conditions of temperature and climate re-

[1] Origin of Species.

quired by the plants of the zones under consideration at any period of the year.

In these tables will be found the isotherms for many places within the tropics. These have been given when any particular industry is identified with such localities,—for example, the tobacco cultivator will be interested in learning the climatological conditions which prevail in Manilla or Cuba; or the orange-grower of New South Wales can compare his climate with that of Nagpore.

It has been found impossible to always obtain the returns of rainfall for the same period of observation as those of temperature, and the periods of observation consequently refer to temperature. In many instances the periods are the same.

IV.—Forestry.

We have seen how the acclimatisation of plants began in prehistoric times, and how it has continued to the present day. Owing to fresh geographical and botanical discoveries, as well as new purposes to which plants are put in the arts and manufactures of civilisation, it is necessary that the supplies of economic plants be maintained to satisfy the increasing demand occasioned by the growing population of the world.

At no period of history has economic botany been of more importance than at present. Civilised nations are rapidly spreading over the world, forming and extending new colonies. These young settlements require fresh fruits, drugs, and other vegetable products for their own consumption. They need staple articles of cultivation, suited for these new lands, of which they can export the surplus when the production exceeds the local demand. They require the assistance of the botanist and chemist in investigating the value of native trees and plants, which, without the help of the scientific observer, might be overlooked. Hence the value of botanical gardens to every new country is not merely in introducing suitable new plants,

but in utilising those which are indigenous to the colony. In these ways the Botanical Departments in Australia have been of immense assistance to the different colonies; and their services would be greatly increased had they the power of restricting the unnecessary waste of timber.

In most of the old countries of the world—India, France, Germany, &c.—the difficulty of procuring timber has led to the establishment of forestry departments, the object of which is (1) to prevent the wholesale destruction of timber by those who have no regard for the wants of future generations, but who only desire to enrich themselves at the expense of their successors; and (2) to plant areas of waste land, which will in time become valuable stores of timber, and keep up the internal resources of these countries.

The denudation of the forests of North America, New Zealand, &c., is a very serious question, which demands the most careful consideration and legislation. Timber is not a material which can be produced when required, but one which present generations must be prepared to plant for the benefit of their children and children's children. It has been already shown how many of the present inhabitants of the globe have been benefited by the forethought and wisdom of their predecessors in introducing new plants from one country to another, and who planted slow-growing trees, from which they reaped little or no advantage, but were conscious that these trees would benefit those who came after them. If we have received such rich bequests from our fathers, or from Nature, it is but fair that our children should not have to complain of the selfishness and extravagance of theirs, who inherited and squandered the stores of wealth provided for them. Firewood is a matter of serious expense to the inhabitants of many lands whose fathers wantonly wasted and destroyed what is an object of concern to their children.

There is an easy remedy for this. Every colony should have a forestry department of properly trained scientific men, who would regulate the felling of timber, replant areas of land for

the future supply of the colony, introduce new trees and useful plants from other countries, and maintain the supply of one of the most necessary articles to mankind. It is false economy to say that any country has plenty of timber, and consequently no need to conserve it. If no steps are taken to prevent waste, want must follow sooner or later, and more than one generation will have to pass before a fresh supply can be raised.

Every new country has certain indigenous plants of more or less use to the inhabitants. By studying the climate of the country, and the nature of the native plants, it becomes tolerably easy to introduce other suitable plants which, as has been shown, may become of the highest commercial importance. Such plants being introduced, the landowner must consider whether he possesses the soil and other requirements suited for any of them. If he does, let him plant them, even if only on a small scale, till he feels safe in extending the cultivation. An old colonist should be able to judge tolerably accurately what he could do with his land, and what he might introduce with safety, but a new-comer will require to be cautious.

On his arrival, he should visit the Botanical Gardens, and carefully observe what plants seem to grow best, and where they originally came from. He will have to exercise some judgment in this ; for there is a great difference between a carefully tended plant in a garden, with all its wants of soil, water, &c., supplied to it, and the same plant grown on a farm or plantation where it has to take its chance. He will have to consider whether he has, on the property which he purchases, a suitable spot where he could put out a few of the trees or plants which he fancies. He should try to compare the climate of the colony with the climate of some country where these trees or plants are regularly cultivated. He should observe what the more intelligent of his neighbours are doing in this way. Many of these valuable trees are ornamental as well as useful, and he should plant a few round his house, in the hope that some day he may turn them to good account.

There is nothing which gives a settler's house a more home-

like look than a good garden. It shows the owner to be a man of thrift and contentment, and affords him much pleasure in thus naturally beautifying his residence. However humble a dwelling may be, the presence of flowers and shrubs marks it as the abode of a man of taste, who has made a home for himself; they are not only a pleasure to the owner, but to others also. Fruit-trees and vegetables soon repay any one for all the attention and care which they require, and not only provide most wholesome change of diet, but may be turned to considerable profit besides. There is no reason why every settler should not have a small experimental garden, where he could grow rarer plants of utility. For example, near Sydney, I saw one garden which was full of useful plants : a magnificent camphor laurel grew in front of the house ; and in every corner of the garden one saw plants which showed the owner to be a man of culture and thought.

In New Zealand I have seen farms where the owners took pleasure in turning their land to profitable account. These experimental industries were being tried on small scales. A patch of tobacco, a few acres of black wattle, an orchard of different kinds of fruits, some osiers, sunflowers, and other useful plants, showed the proprietors to be enterprising and intelligent men. These men are particularly valuable colonists, for they develop the resources of the colony, and encourage others to attempt new products.

No agriculturist should rely upon one string to his bow ; it *may* snap. The staple crop of any country is always liable to disease or financial depression. Had the West Indian planters of fifty years ago developed the resources of their estates by planting cacao, cocoa-nuts, &c., instead of relying upon the sugar-cane only, their properties would not have depreciated in value to the extent which happened. Had the Ceylon planters of ten years ago paid more attention to tea and cinchona, the failure of coffee would not have ruined so many families. Wheat and wool may be depressed in price, but the farmer who has planted other crops has not to rely upon these

alone; he may have wattle-bark, oil-seeds, or arrowroot, which will enable him to tide over the evil day. Even when cultivated on a small scale, these extra crops sometimes come in conveniently, and help to make ends meet. There can be little doubt that the profits of a colonial farm might be considerably increased by adopting new cultivations suitable to the soil. There are always odd corners on a farm which might be turned to better account than they usually are. For example, on alluvial land, willows might be grown; cork oaks might be planted round fields; *Stillingia sebifera*, the Chinese tallow-tree, could be grown near the house; stony land would carry olives; lupines would grow on sandhills, and help to bind the sand. On the sea-coast itself, squill and colocynth would require little care. In the warmer parts of Australia, the carob would be not only an ornament, but would supply the farmer with most fattening food for his cattle. Even cottages could always grow a few mulberry-trees for feeding silkworms.

Plant-life is liable to destruction from many causes. The greater the area under cultivation with one crop, the more likely are diseases and insect pests to appear, and the more formidable the proportions to which they will increase. Where many human beings are crowded together in a city or ship, we know that disease is more likely to break out, and more victims suffer, than in places where the population is sparse. The same rule holds good among plants. Therefore a small field or garden is less likely to contract disease than a large one; and even if attacked by some animal or fungoid plague, the less financial damage will result. Unfortunately it is not always possible to separate fields, but when they are devoted to perennial plants, it is safer to do so. When a large extent is under the same plant, the effects of a plague is disastrous. The vines of Madeira were destroyed by oidium, the coffee estates of Ceylon by *Hemileia vestatrix*, both of which are parasitic fungi. The ravages of the Colorado beetle, codling-moth, phylloxera, and other insect pests, are, unfortunately,

only too well known. The latter has spread from vineyard to vineyard, doing incalculable damage to the *vignerons* of South Europe; it has even found its way to Australia. The codling-moth spread from America to New Zealand and Tasmania.

The United States has set the world an example in dealing with insect pests by forming an Entomological Department in connection with the Department of Agriculture. Miss Ormerod[1] has done good service to the farmers of the United Kingdom by devoting her time to injurious farm insects. But, so far as I am aware, there is no paid government entomologist in the United Kingdom or any British colony. The consequence is that our agriculturists have no one to whom they can apply for assistance when their farms are attacked. This is far from what should be. Entomology is a branch of economic science of the greatest importance in all agricultural countries. Every museum should have cases showing the principal injurious insects in all their different stages. Children in country schools might be taught the difference between hurtful insects and those friendly insects which prey upon the former and so aid man. Colonial governments might do much service by publishing little manuals on the subject, with hints for prevention and destruction.

Fungoid pests are much more serious matters. Insect pests are more conspicuous to the ordinary observer, who can often form tolerably accurate opinions as to what is wrong; but parasitic fungi are so subtle, so minute, that they require all the skill of the trained microscopist to discern their life-history. Even after their history is known, science may be unable to suggest any effectual remedy against them, as was the case in Ceylon with the coffee-leaf disease fungus.

A common mistake among those who go to a colony and take up land, is to buy more than they have the capital to work profitably. This is a very usual and very serious error, and one which is almost sure to end in debt and disappointment.

[1] Manual of Injurious Insects. Miss E. A. Ormerod. 3s. Simpkin, Marshall, & Co.

The days when land doubled itself in value every few years are almost gone—anyhow these chances are now seldom met with. The immigrant should content himself with buying only as much land as he can do justice to and has the capital to develop. It is a great temptation for the new-comer to consider himself the owner of a large farm; but unless he can utilise his land, it is a poor investment. It is much better to take up only as much land as he can really cultivate, and to increase the fertility rather than to half-cultivate a larger extent. A small estate, well cultivated and in thoroughly good order, is a pleasure to the owner; but a large property, which is in bad order, is only a source of disappointment.

It is a profitable business for the owner of a small colonial farm to devote part of his land to nurseries of useful and ornamental trees, for which he will probably find a ready sale among his neighbours. If the farm is near a town, the owner will probably be able to sell fruit and vegetables to great advantage. With the refuse of these he can feed pigs, which will not only pay him to sell to the butcher, but will also pay him in manure, with which he can maintain the fertility of his farm. If he devotes himself to the cultivation of fruit-trees, he will find poultry useful in destroying insects and a source of profit besides. Whatever branch of agriculture or horticulture he takes up, let him follow the example of the Continental farmers and the Chinese, and cultivate highly.

I cannot better conclude this chapter than by reminding the reader of the shrewd old Laird of Dumbiedikes, whose dying advice to his son was: "When ye hae naething else to do, ye may be aye sticking in a tree; it will be growing, Jock, when ye're sleeping."[1]

[1] Heart of Mid-Lothian.

FRUITS.

CITRUS, OR ORANGE FAMILY.

Nat. Ord. AURANTIACEÆ.

THE origin of the different members of this family is extremely doubtful, these fruits having been cultivated from a remote period of antiquity. Some botanists think they have all sprung from the citron, *C. medica;* others believe the different members to be distinct species. The citron is mentioned by Theophrastus (B.C. 300) as growing in the north of Persia. The orange and lemon seem to belong originally to Cochin China, or China and India. The orange was probably introduced into Europe by the Moors in the eleventh century. Some of the first orange-trees planted in Spain are still to be seen in the old Moorish town of Cordova: these trees are said to be six or seven hundred years old. Sir Walter Raleigh introduced orange-trees into England.

Risso of Nice, the great French authority, classes the different species of Citrus as follows:—

Citrus aurantium,	The Sweet Orange,	Oranger,	45	varieties.
" *bigaradia,*	Sour Orange,	Bigaradier,	31	"
" *bergamia,*	Bergamot,	Bergamotier,	5	"
" *lumia,*	Sweet Lemon,	Lumier,	12	"
" *limonum,*	Lemon,	Limonier,	47	"
" *limetta,*	Lime,	Limettier,	9	"
" *medica,*	Citron,	Citronier.		
" *cedra,*	Cedrat,	Cedratier,	17	"
" *decumana,*	Shaddock or Pomeloe,	Pompelmouse,	6	"

The Sweet Orange (*Citrus aurantium*).

Humboldt gives the geographical bounds of the orange in the northern hemisphere as being between the 12th and 40th parallels of latitude, and the mean yearly temperature required by the tree as 64°. Du Breuil says they do not grow in open air beyond 43° N. lat.: even then they must have complete shelter, and the earth, at a depth of eight inches to a foot, must have a temperature above the freezing-point. He goes on to state that oranges have been known to resist a temperature of 14° F., when the frost was not continuous enough to penetrate deep into the soil, and the thaw took place on a cloudy day. "These trees are equally sensitive to snow and hoar-frost, especially when these continue for some time and melt under the influence of the sun. . . . Oranges may be cultivated in the open air with safety wherever the temperature does not sink below 26°.6 F. In the most favourable parts of Provence this is not to be found beyond 1200 feet elevation. Nevertheless the different varieties of oranges are not equally sensitive to the cold of winter. The hardiest are the sweet oranges and the sour oranges; after them the bergamots; the lemons and the citrons are the ones which require most heat —they succumb when the thermometer falls to 28°.4 F." The localities in France where the orange is cultivated are the most sheltered parts of Provence—viz., Cannes, Nice, Vence, Hyères, Le Canet, Ollioules, Toulon, St Paul, and Antibes. Even at these places the trees are liable to be killed by frost.

The geographical distribution of the orange as a cultivated plant comprises the whole of Portugal and Spain, where the surrounding circumstances are favourable and the elevation not too great; the very south of Provence; the Riviera of Genoa; then we do not find it grown, except in gardens, till we pass Terracina (lat. 41° 17′ N.) and approach Naples. It grows in Albania, Corfu, and throughout Greece; Persia, on the shores of the Caspian Sea, Afghanistan; China and Japan where the winter temperature does not fall too low, but not

beyond the 40th parallel of latitude. In the United States oranges grow south of the 35th parallel of latitude: even then the excessive frosts occasionally prove too much for them, and it is not perfectly safe to grow oranges till one reaches Pilatka in Florida (lat. 29° 30′ N.) On the western coast of America the orange can be grown as far north as lat. 35°. Mr Moore, in his work on 'Orange Culture,' says: "The area of the States with climate suitable for growing the orange is comparatively small: . . . a few of the more southern counties of California, and that portion of Louisiana along the Gulf coast, can be made available for growing oranges profitably. In Florida the climatic conditions are more favourable." The above give us an approximate idea of the most northerly limits where the orange can be ripened. I do not say "produce fruit," for the orange, trained on espaliers and only slightly sheltered by mats in winter, has borne fruit in gardens in Devonshire.

Under exceptional circumstances we have seen that oranges grow at Oviedo in Spain (lat. 43° 22′ N.), and Nice in France (lat. 43° 44′ N.); but these places have the advantages of perfect shelter from all cold winds and immunity from frost, which is the greatest enemy of the orange in its northern limits. As it is, where a plant of so much value as the orange can only be grown with difficulty, it stands to reason that it must there receive the most care and attention, and probably is better cultivated than in countries where it grows more easily. But one would hardly expect to find the finest fruit at the extreme limit where it ripens. The fruit grown there would probably be deficient in sweetness, nor would it have the quality or flavour of fruit grown well within the geographical bounds; and in the case of the orange, it would not have so much of the delicious refreshing juice which is the best part of the fruit.[1]

The orange can be grown to perfection anywhere within the

[1] "It requires high heat and sunlight to convert the acids of the orange into glucose, develop the aroma and other qualities in their greatest perfection."—Dr Davis.

tropics where the climate and soil are at all favourable. I have eaten most perfect oranges in Ceylon (lat. 7° N.), grown at 1000 feet elevation, and they were one of the most common fruits of the country. It is true that they were not generally of good quality; but this was due to the carelessness of the Singalese, who took no trouble to improve the quality of the fruit they grew. Mr Wallace, in describing the village of Rurúkan in the Celebes, situated about 3500 feet above the level of the sea, in latitude 1° N., says: "Oranges thrive better than below, producing abundance of delicious fruit; but the shaddock or pompelmouse (*Citrus decumana*) requires the full force of a tropical sun, for it will not thrive even at Tondano, 1000 feet lower."[1] Still I am inclined to believe that the region of the finest oranges is farther from the equator; and as I have never seen any fruit to equal, as a whole, that of Jamaica and the West Indies, I fancy the orange will be found in the greatest perfection about the 18th to the 20th parallels of latitude. But it must be remembered that exposure, soil, and the surrounding climatic conditions, have more influence on the quality of this fruit than a slight difference of temperature, so long as the tree is well within its geographical range.

A greater degree of heat is required to bring the orange to absolute perfection than many people consider necessary. Moreover, this heat must not be communicated to the tree by an irregular distribution during seasons which are sometimes very cold and at other times intensely hot; but the temperature throughout the year must be regular and equable, and to obtain such a temperature it must be looked for in countries having insular climates, and not far removed from the sea. Within the tropics, distance from the sea does not seem to

[1] Anno Bom, an island on the west coast of Africa, lat. 1° 25′ S., grows excellent fruit. "Oranges are the fruit with which the island mostly abounds; the quantity of them is incredible, and they may be obtained all the year round; they are full of juice, and of an exquisite flavour."—Findlay, South Atlantic Ocean.

matter as much as it does beyond the tropics, where the temperature shows more marked variations. This is shown by the quality of the oranges grown at Nagpore. At Tucuman, in the Argentine Republic (lat. 26° 50′ S.), the oranges are said to be of the greatest excellence. As a general rule, however, the best oranges are grown at no great distance from the sea.

In considering the geographical limits for the cultivation of this fruit, it must be remembered that the south of Europe is most exceptionally situated for warmth, having a coast-line more deeply indented than any other part of the world of similar size, and that this coast-line is bounded by an inland sea, beyond which is the great African continent, which raises the temperature of the Mediterranean coasts. Therefore, in South Europe we find plants growing at a greater distance from the equator than in any of the other continents, and that in exceptionally situated localities the orange ripens as far north as lat. 44°, while in America it cannot be successfully grown beyond the 35th degree of latitude; and we may say the same of Asia, with the exception of the land to the south of the Caspian Sea. We may, accordingly, take the northern boundary-line of the regions where oranges are grown with safety, to run about as follows:—

West coast, North America, .	lat. 34° N.
East do., do., . .	" 31
Bermuda, ...	" 32 30′
Europe, ...	" 44
Western Asia, . . .	" 37
Eastern do., . . .	" 34,

south of which oranges will grow in all suitable localities, even in equatorial regions, till one passes beyond the Tropic of Capricorn.

In the southern hemisphere the orange is cultivated at—

Buenos Ayres, . .	lat. 34° 38′ S.
Cape Town, . . .	" 34 36
Adelaide, ...	" 34 53.

It is difficult to say how far south the orange can be profitably cultivated, probably not beyond lat. 35°, to produce really good fruit, except in very favourable places, as there would not then be sufficient heat to ripen the fruit properly. The cultivation is being tried in Victoria, and at Wangarei in New Zealand.

On looking at the tables of monthly temperatures, it will be noticed that where the orange ripens, the mean temperature of the warmest month is never less than 70°, except at Oviedo in Spain, and Los Angeles in California. It will be further noticed that the sum of the temperatures of June, July, August, and September in the northern, and of December, January, February, and March in the southern hemisphere, give a total amount of heat of at least 275° F. This may afford some indication of the minimum amount of heat required to ripen this fruit; but light is also an important factor to consider, and it is probably owing to the unclouded skies of California that the orange ripens there. In the north of Spain the orange ripens in sheltered valleys where the temperature is above that recorded at Oviedo.

It is interesting to notice the cultivation of this fruit under glass. Mr Loudon says Ayres never suffered his orangery to be heated above 50° by fire-heat until the end of February. When the trees show blossom it is increased to 55°, but never allowed to exceed 60° by sun-heat, the excess of which he checks by the admission of air till the early part of June, when "he begins to force the trees by keeping the heat in the house up as near as possible to 75°. For I do not consider that either citrons, oranges, lemons, or limes can be grown fine or good with less heat."[1]

The temperature which Mr Loudon considered necessary to bring the orange to perfection, is in accordance with what we find in looking at the summer temperatures of those places which are celebrated for their fruit: in corroboration of which, I am informed that oranges grown near the Clarence river in New South Wales are superior to those grown near Sydney;

[1] Encyclopædia of Gardening.

and the Malta oranges are much better than those grown at Naples. But I have found that oranges grown within the tropics are superior to those from extra-tropical countries, when the trees receive the necessary amount of cultivation and care which they require. The fruit is one which delights in sunshine, and the intense heat of the summers of Malta, Seville, &c., is required to convert the acids of the fruit, and to thoroughly develop the quality and flavour, after which the fruit requires considerable time to mature.

We must now consider the cultivation of the orange. The soil should be rich and fresh, neither too dry nor too etentive of moisture. A loam or light clay containing a good deal of vegetable humus will answer well. Du Breuil says, when describing the soils suitable for this cultivation in France: "Oranges are not very particular about the nature of the soil; they only fear limestone, more or less pure, soils completely siliceous, and retentive humid clay." It is curious that in Jamaica limestone does not seem to affect the trees, and I have seen them thriving where the subsoil was calcareous marl. In Florida, soils containing salt—chloride of sodium—are said to be "positively poisonous to the orange." As a rule, oranges grow best when near the sea, provided they are thoroughly sheltered from the violence of strong sea-winds. This proximity to the sea makes the climate more equable, and lessens the cost of conveying the fruit to market. But it is not absolutely necessary to the production of the fruit, as the oranges of Nagpore in the Central Provinces of India, and Tucuman in the Argentine Republic, are both celebrated.

The cultivation in France[1] is conducted thus: A warm sheltered spot is chosen for a nursery, the young plants being very easily killed by frost. The soil must be rich and deep, and trenched all over to a depth of two feet. The largest fruit are selected from some neighbouring plantation, care being

[1] In describing the French system of cultivation, I have chiefly followed that described by M. Du Breuil in 'Arbres et Arbrisseaux à Fruits de Table.' Paris: G. Masson. 8 francs.

taken to choose those only which are fully ripened. These fruits are exposed to the sun till they begin to show signs of decay, when they are soaked in water for a few hours. The seeds are washed out, and only those retained which sink when put in water. It is better to put the seeds in the nursery as soon as possible, but they will keep in sand slightly moistened. The seeds are planted in boxes, or in the nursery-beds in rows one foot apart, and covered with mould to a depth of one inch and a half. These beds should be shaded by a light covering of leafy branches on a frame about three feet above the beds; but it must be arranged so as to admit light and air. The seed is sown in April, when the temperature is about 59° F. As a rule, only the common sweet and sour oranges are grown from seed as stocks on which to graft the finer varieties. In a year or two the seedlings are transplanted to the nursery from the seed-beds. This is usually done in April, when the foliage begins to appear. The roots are not touched, but the young branches, prickles, and the leaves at the base of the stem are removed. The plants are put two feet apart every way. If the future trees are to have short stems, they are grafted a year after transplanting. For full standards a longer period is necessary, and the whole vigour of the plant must be thrown into the stem by pinching off the ends of the branches and removing the lower branches entirely as the tree grows—also all leaves situated low down, and all thorns—till the plant is from five to six feet high, when they are grafted. While the plants are in the nursery they must be carefully weeded every month, and watered in dry weather. Every spring the soil must be carefully dug with a three-pronged fork, so as not to cut the roots. Should any of the trees grow bushy, instead of showing a clean stem, one of the lower branches must be tied up to the stem, and the other branches cut off. In time the branch trained up the stem will take the place of the true stem, which must then be cut off a little above where this branch joins it.

The favourite stocks for grafting upon are the common sweet and sour oranges; the former is used for trees which are to have short stems, and the latter for trees with high stems. After the stocks have been planted in their final resting-places, a year is allowed to pass before they are grafted. Almost any sort of graft may be employed. They may be shield-grafted with a dormant bud from July to September, with a pushing-bud from April to June. In September cleft-grafting, veneering, and inlaying are used. In warm countries shield-budding is the only plan adopted, and the reversed incision is used. Two shields are usually put on each tree to ensure success. After budding, all suckers and shoots which appear on the stem must be immediately taken off, with the exception of those nearest the graft, which draw the sap towards it: the growth of these is, however, checked by pinching. The head of the stock is removed in the following spring.

Oranges may be grown from cuttings, but give less robust trees than those grown from seed, being neither as hardy nor as vigorous as the latter, though they grow quickly at first. They may be also grown from layers; but sweet oranges propagated by layers or cuttings do not succeed as well as lemons, citrons, and bergamots.

A curious manner of layering is practised in the Ionian Islands. A ring of bark, one inch wide, is taken from a branch; this branch is bound with flax and passed through a small box of earth, supported on a stake to the necessary height. The earth is watered daily. At the end of six months for a lemon, or ten months for an orange, the branch may be cut from the tree. The box is taken to pieces, and the rooted branch planted. For two or three days before the branch is cut, the earth should not be watered.

In planting trees in an orangery, round holes are dug three feet in diameter and the same in depth; but where the soil is dry and parched, the size of these holes is nearly doubled. The earth taken out is heaped at the sides of the holes, and

exposed for two months to the action of the weather. The trees planted on a large scale are mostly standards, five or six feet high, and one inch and a half in diameter at three feet above the collar. The trees are planted in April, care being taken not to injure the rootlets, which are best protected by removing them with the ball of earth in which they were growing. The holes must be well manured with natural or artificial manures, which must be heaped in the centre of the hole in a cone shape, and be well mixed with earth. The tree is placed on the apex of the cone, and the roots are spread around, so as to have easy access to the manure. The earth should be filled up a little above the level of that at the top of the hole, to allow for the depression which always takes place. After planting, the trees should be well watered several times.

The after-treatment of the orangery consists in turning the soil twice yearly if it is stiff, and once if it is of a light nature. The first should take place after the pruning in spring, when the land should be dug or ploughed to a depth of fifteen inches; the second takes place in autumn, and only dug to a depth of ten inches. Where the soil is light, and there is only one digging or ploughing, it is sufficient to carry it to a depth of twelve inches, and it should take place in spring. The digging should be done with forks, not with spades.

The head of the tree should be trained to a round form, so as to expose as great a surface as possible to the action of the light and heat. Those shoots likely to spoil the symmetry of the tree should be taken off as soon as possible. The head of the tree should be kept open so as to allow light and air to penetrate freely. In pruning, all dead wood, cross-branches, and gourmand shoots should be taken off. The spring is the best season for this work.

In Florida the system of cultivation recommended by Mr Moore is as follows: The seeds are sown in boxes, or sprouted in sand, and planted in rows in the nursery. The nursery should be surrounded by forest, and the soil is dug ten or

twelve inches deep. Rows are opened four feet apart and eight inches deep, and filled to within two inches of the top with well-rotted manure. Plant the seeds three inches apart, and cover with an inch and a half of soil. If plants from seed-beds are to be put out, plant them in the rows, leaving six inches between the plants: these seedlings should have four or five leaves each, and the holes for their reception should be five inches deep. If the tap-roots are too long they may be shortened. The transplanting should be done in wet weather. If the sun is hot, shade the plants for a few weeks. Stir the soil frequently to a depth of two inches. Eight months before removing the young plants from the nursery, root-prune them by pushing a spade eight or ten inches deep on each side, and six inches from the rows. The trees are budded in the nursery at one year old, when the sap is running freely: only one bud is inserted. Budding is preferred to grafting. The buds should have well-developed eyes, and be neither too old nor too young.

A few forest-trees should be left in the grove as a safeguard against frost. The soil of the grove should be well broken up. Late winter and early spring are the best planting seasons. The plants are carefully raised from the nursery, any damaged pieces of root cut off, and the tap-root is shortened. The hole is three feet in diameter, two inches deep at the centre, and six inches deep at the outside edge, leaving a mound of earth in the middle in the shape of an inverted cone. At the centre a spade is worked into the ground to a depth of eighteen inches, when the tap-root is inserted and the earth packed carefully round it. The lateral roots are spread round the cone, and two inches of soil firmly trodden over them; but the top covering of soil is left untrodden. The young tree has its branches trimmed in proportion to the root-pruning it has received. Deep planting is injurious.

Mr Moore recommends high cultivation. "As far as the roots have extended, the surface should not be stirred deeper than three inches. Beyond the reach of the roots, it is well to

cultivate deep and frequently." This is done by a plough. While the trees are young, crops of garden vegetables are taken. Weeds and grass should never be allowed to grow to any size. Mulching is recommended. The trees are pruned so as to "keep an open head to the tree." Only the most vigorous lateral branches are retained: these are trimmed almost to a point, leaving only a few of the small terminal branches. Prune in spring. The following spring, trim these lateral branches the same way, allowing the first laterals to rebranch nearer the trunk. An open head is necessary for the free admission of light and heat.

Manure heavily—especially where garden crops are taken—between the trees, scattering the manure over the ground. Manure in spring. The nature of the manure should depend upon the character of the soil. Guano and potash are good when added to cattle-manure. Vegetable manures are very good.

In gathering the orange, cut the stalk close to the fruit on a dry day. Seventy to one hundred oranges may be put two deep in a box in the packing-house till the surplus moisture has escaped, which will be in about five days' time. The cases should be $8 \times 16 \times 27$ inches, with a partition in the middle, and lined with paper. The fruit should each be wrapped in paper, and packed compactly together to keep them from shaking, all damaged fruit being rejected. Another cultivator lays great stress on cutting the fruit from the stem, and handling it carefully till it reaches the drying-house. Here he lays them in rows two deep, exposed to as much light and air as possible for from two to six days, till the moisture is evaporated out of the skin.

The stocks most in favour in Florida are sweet seedlings and the wild sour orange: the latter are hardier and more robust. Ungrafted seedlings are a mistake, as budded trees will grow as large as seedlings if they are prevented from overbearing while young.[1]

Other Florida cultivators make the holes for the trees at

[1] Davis.

least three feet in diameter and two or three feet deep. All roots, &c., are removed from the earth, which is mixed with one pound bone-dust and returned to the hole. Before planting, the holes are opened sufficiently to allow the roots being carefully arranged, the earth is sprinkled over them till the hole is filled, when the soil is firmly pressed round the tree with the foot, leaving the collar of the tree an inch above the level of the ground. The tree is then pruned. Vegetables are sometimes grown in the rows, but should never be planted within five feet of the young trees, and the ground they grow on should be carefully manured.

In the case of budded trees, if the shoot requires support, a stake is driven into the ground beside it. When the shoot is three feet high the top is pinched off to encourage the growth of branches. The branches of the trees are trained to spread laterally, so as to form a wide open head which will admit plenty of light and air. Old trees receive but little pruning, only dead wood and superfluous wood growing inwards are removed. Old orangeries are sometimes improved by running a plough through the ground, which gives a rough root-pruning, said to be very beneficial.

The surface of the soil is kept clean by running the cultivator over it whenever weeds appear.

Dr Davis considers the orange requires more nitrogenous manure before it comes into bearing than afterwards. For young trees he considers well-rotted stable-manure best. "Young growing trees require fertilisers rich in carbon, nitrogen, phosphates, and potash. Older bearing trees require manures rich in phosphates, potash, and lime." He is opposed to mulching. He recommends as manure for old trees, muck and an occasional dressing of half a bushel of lime to the tree, or eight to ten pounds of raw ground-bones broadcast round the tree and harrowed in every four or five years. He points out the need of returning potash to the soil.[1]

[1] A Treatise on the Culture of the Orange. By G. W. Davis, M.D. Ashmead Bros., Jacksonville, Fla. 50 cents.

The orange was introduced into New South Wales in 1788. The first orangeries were on the Parramatta river, then at Parramatta itself. Now, the orange-growers have to go farther from Sydney to secure land at a reasonable price; but the orangeries are seldom very far from one of the numerous arms of the sea, which run inland for considerable distances. The best situation for an orangery is a slope of land facing the north-east or east, which affords natural drainage and gets the morning sun. It should be protected by belts of trees from the winds of the west and north-west; but the trees must not shade the orange-trees from the sun.

The land is cleared, ploughed, and trenched, after which it is planted. Seedling-trees are now never grown, owing to the length of time they take to bear and the uncertainty of the result. The orange when grafted on a lemon stock is not so hardy, nor does it last as long as those grown on orange stocks, especially when the stock is the Seville or bitter orange, which are less liable to disease than the former. One experienced grower told me he would not use a lemon stock, as the result was a sour, thick-skinned fruit. "I want to grow oranges, not lemons or half lemons," he said. He preferred the sweet orange as a stock. The stocks are budded four inches above the collar.

When young, the orangery may be kept clean by using a cultivator, keeping it well away from the roots. Round the trees the weeds are destroyed by hoeing to the depth of an inch. When the roots have spread, the hoe is the only instrument used for cleaning the land. The general opinion seems to be against cropping the land between the trees, even when the orangery is young. Manure is forked into the ground round the trees. Cattle-manure, leaves, and bone-dust seem to be most highly thought of.

The holes in which the trees are planted need not be more than one foot deep, and should be filled nearly to the surface before the tree is planted. Layers make good plants. Planting too closely together has been found to be most hurtful.

The favourite distance is twenty feet apart, though many cultivators prefer to have their trees twenty-five feet apart. The best season for planting is the latter part of spring, during the month of August. Where the subsoil is retentive, covered drains are used.

Formerly the trees used to be over-stimulated. The refuse of boiling-down establishments was given to them freely. The result of too much manure was a few heavy crops, followed by the decay of the tree. Manure is now applied more sparingly. Trees are sometimes weakened by being allowed to bear before they have sufficient strength to mature their crop without injury to themselves.

It is a common custom in New South Wales to estimate the yearly crop of a full-grown orange-tree at £1. The following is the probable return from an acre of grafted trees :—

The fourth year	after	planting	the return would be	£10
" fifth	"	"	"	15
" sixth	"	"	"	25
" seventh	"	"	"	40

Fine trees in full bearing have given a return of £100 per acre. Large trees, eighteen years old, were shown me, which bore from 150 to 200 dozen fruit each tree, but the latter yield is most exceptional. The value of the fruit depends on the quality, and fluctuates from eight shillings to £1 per case of fourteen dozen fruit. I heard of particularly fine fruit which fetched £2 a case.

The most serious disease is a root-rot which attacks the trees a little below the collar. The only remedy is to bare the main roots for a short distance round the stem, and expose them to the sun for a short time. Aphis attacks are common. The remedy is an application of sulphur and soft-soap. The success of the orangery depends greatly upon the care taken at the commencement. The land should be trenched from twenty inches to two feet deep. Great care is necessary in the selection of good plants. After the land is planted the

cost of upkeep is comparatively slight. The cost of clearing, ploughing, trenching, and planting an acre of land is about £30.

It is important to notice the distance apart at which orange-trees are planted in different countries. In gardens in France, where the trees are espaliers, half standards and more or less dwarfed, the distance between them is from ten to seventeen feet; in the open, where the trees are full standards, they are planted twenty feet apart on good soil, and seventeen feet on poor land. In the Azores, the trees are from twenty-five to thirty feet apart, the land being cropped between the trees. In Florida, Mr Moore gives for budded trees on sour-orange stocks, 21 × 21; budded trees on sweet stocks 25 × 25; and sweet seedlings 30 × 30. In the south of Europe the distances are much the same as in France. For the West Indies the distances given by Mr Moore for Florida would be suitable.

The orange-tree bears enormously. At Sydney, a mandarin orange-tree has given 4000 fruit in a season, a navel orange 1200; the common orange is said to have yielded 12,000 fruit in a season—but this must be a most exceptional case, as 1200 oranges is considered a large crop. In Jamaica, from 300 to 900 fruit grow to a tree; but the fruit is much larger than the Sydney, and the trees are seldom cultivated.

The Nagpore oranges are said to be the finest in India.[1] Nagpore is in the Central Provinces, in lat. 21° 8′ N. The fruit is thin-skinned, of great size, and exquisite flavour. The tree bears heavily. The trees are propagated by budding and grafting by approach. Sweet-lime stocks are used. A rocky *débris* of limestone and sandstone is said to be the soil which suits them best. The orange-tree blossoms in February and ripens in November; it blossoms a second time in July, and the fruit is ripe in March. This crop is much sweeter than the former.

In Ceylon there are several varieties, but the natives take no pains to improve their trees by cultivation. The trees bear

[1] Gardening for Bengal. Firminger. Thacker and Spink: 1874.

heavily, but receive little or no attention, and are never grafted. The fruit is almost invariably green when ripe. Dr G. Bennett wonders if this and the Tahiti orange are the green orange of Arcot, a species unknown in Europe.[1]

The flowers of the sweet orange are white; the leaves (fig. 1) sharp, of an oblate oblong shape. The petiole is not so markedly winged as in the bitter orange, but is always so to a greater or less degree. The fruit is generally an oblate sphere, of a golden-yellow colour when ripe; it is full of a delicate pulp and sweet refreshing juice. The fruit is sometimes pear-shaped, and occasionally elliptical. The tree grows higher than any other member of the Citrus family, sometimes attaining a height of thirty-five feet or more. The wood is valuable for inlaying purposes in cabinet-work.

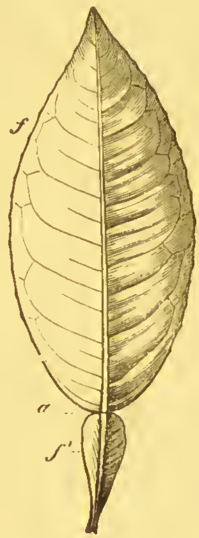


Fig. 1.—Compound unifoliate leaf of the Orange (*Citrus aurantium*, L.) *f* Lamina; *f'* Petiole, winged on either side; *a* Point of union of the two, marked by an articulation.

When this fruit is grown where the temperature is barely sufficient to ripen it, it is better to grow it as an espalier or cordon. Professor Balfour notices a curious property of this tree, which I give in his own words: "The orange presents a singular phenomenon in respect to maturation of its fruit. This is generally looked upon as ripe at the end of the first year; but it often happens in the south of Europe that, in order to obtain oranges of the best quality, the fruit is allowed to remain for a second summer on the tree. It is not easy to say what is the real term of maturation in this fruit in its natural state."

All varieties of the orange family grow to perfection under irrigation. In tropical countries this is probably the best way to grow these fruits.

The great requirements of the orange-tree are sunlight and

[1] Wanderings of a Naturalist.

shelter: where these are to be found, combined with the requisite degree of temperature, the cultivation is simple. The analysis of the ash of the orange given by Dr Nichols is: potash, 38.7; soda, 7.6; lime, 23.0; magnesia, 6.5; ferric phosphate, 1.7; sulphur, 2.9; silica, 6.2; phosphoric acid, 14.1. The analysis of the fruit shows: water, 85.7; cellulose, 1.1; mineral matter, 0.5; albumen, 1.0; glucose, 8.3; pectose and gum, 1.7; citric acid, 1.7.

Fig. 2.—Flowering branch (*a*), fruit (*Hesperidium*) *b c*, of an Orange (*Citrus vulgaris*, var. *bigaradia*); *d* Flower complete; *e* Pistil; *f* Transverse section of ovary.

Seville Orange, Sour or Bitter Orange (*Citrus bigaradia*).

Does not grow quite so high as the sweet orange. Has a larger leaf with a highly winged petiole (fig. 2). The flower is larger and more highly perfumed. The fruit is of a red orange colour, the skin being rugged, rough, and porous. The pulp is yellow, and the juice extremely bitter.

The fruit is much used in making marmalade and preserves. The fruit is used for various purposes, as described hereafter, and the flower is in demand for the perfume it contains.

Orange-flower Perfume.—In the early morning the blossoms are collected as soon as the petals begin to fall, by shaking the tree over a sheet spread on the ground. A tree yields from two to ten pounds of flowers. The perfume is generally extracted by enfleurage, as follows: A frame is required six feet high, thirty inches wide, and twenty inches deep; in this grooves are cut to allow trays one and a half inch deep to run. These trays are covered with wire-gauze. Between every two trays there is a sheet of stout glass framed; on this grease or vaseline is thickly spread. The whole should be as air-tight as possible. Every morning fresh flowers must be put in the wire-gauze traps; and this is continued for a month or two, when the grease is removed.

The grease is made as follows: Melt equal parts beef-suet and lard, or mutton-suet, beef-suet, and lard, well together. Pound well in a mortar, and wash till perfectly clean. Melt over a slow fire, adding three ounces powdered alum and a little salt to each hundredweight. Heat the grease till it begins to bubble, and then strain into a deep pan, and let it clarify for two or three hours. The clear grease is then put on a charcoal-fire, and three quarts rose-water and half a pound powdered gum-benzoin added; it is gently boiled, and all scum taken off till it ceases to appear. Put the grease in deep pans to cool; when solid, remove any water there may be in it, liquefy, and pour into vessels for future use. Besides grease, glycerine, vaseline, and paraffin are all used. Formerly, instead of using grease in enfleurage, oiled linen was employed to absorb the odour, and afterwards squeezed in a screw-press.

A superior system is by employing Piver's pneumatic frame, which has two bellows on the top which send a constant current of air through the flowers.[1] The most primitive is the

[1] For a fuller description, see Spon's Encyclopædia of the Industrial Arts, p. 1456.

Spanish, which consists of two bowls—the upper one, or cover, being lined with grease, while the lower holds the flowers.

To extract the perfume from the grease, or "pomade," as it is called after being scented, chop up eight pounds pomade, put it in one gallon sixty over-proof alcohol, and let it remain for one month at summer-heat.

Essence or Extract of Orange-flower is prepared by tincturation. Four ounces of orange-flowers are steeped in one gallon alcohol till all the perfume has been absorbed by the spirit. This preparation is also known as extract of neroli.

Essential Oils of Orange.—Bergamot or lemon is expressed thus. The peel is cut from the pulp in three longitudinal slices, leaving the pulp in a triangular shape. The peel and pulp are kept separate. Next day the outer surface of the peel is bent convexly, and pressed four or five times against a flat sponge held in the left hand of the workman. From time to time the oil is squeezed from the sponge into a vessel, from which it is drawn after the watery fluid separates from the oil. Four hundred oranges yield from nine to fourteen ounces of oil. The pulp is distilled for the small amount of essential oil it contains. When lemons are thus treated, the pulp is pressed till the lemon-juice is all extracted, and then distilled.

Petit-grain Oil.—Prepared from young tender shoots and leaves of both sweet and Seville oranges, the latter being most valuable. The oil is obtained by distillation with water.

Neroli, or Oil of Orange-flower.—Obtained by distilling the flowers of the sweet and bitter orange with water. The bitter orange gives a superior oil. It is very fluid, is lighter than water, in which it is slightly soluble. One hundred pounds of flowers give from three to six ounces of neroli. It is generally adulterated with alcohol or essence of petit-grain. Essential oils of orange, lemon, or bergamot are better extracted by aid of an implement known as the *écuelle à piques*, a saucer-shaped vessel of pewter about eight inches wide, with a lip on one side. The bottom is armed with numerous brass pins about half an inch

high, which stand upwards. The centre has a tube five or six inches long and half an inch in diameter, closed at the farthest end. The whole resembles a shallow funnel. The peel is rubbed against the pins by hand, and when the tube is full of oil it is emptied into another vessel.

The peel of the bitter orange is used in medicine as an aromatic tonic, but more frequently for counteracting the nauseous taste of other medicines. The most common forms are syrup of orange, tincture of orange, and confection of orange.

In 1881 the exports of essences of oranges, &c., from Reggio, were 3064 kilometres—value, 55,122 francs. In 1882, 3956 kilometres—worth 82,976 francs.

Bergamot Orange (*Citrus bergamia*).

Flowers small, white, and highly scented. Leaves oblong, elongated, acute, or obtuse; the under side is pale. Petiole more or less winged. Fruit pale yellow, pyriform or depressed; the oil-vesicules concave; pulp acid; the whole highly perfumed. The fruit is grown for the essential oil it contains, which is extracted from the green fruit by the *écuelle*, or by the old process of squeezing it against a sponge. One hundred oranges yield about three ounces of oil. The oil, a few weeks after it has been extracted, deposits a substance known as "bergamot camphor," which is distilled to recover any oil it contains. The bergamot orange is not the only member of the Citrus family which deposits camphor; the other oranges do so too. Oil of bergamot is also got by distilling the peel with water, but the product is not so fragrant as that obtained by expression. The yield of oil is about the same by either process. The specific gravity of the oil is .875 to .885. The flowers also contain a delicate perfumed oil or essence which is highly prized by perfumers. The bergamot tree is hardy. It is mostly grown at Reggio, in Calabria.

Lemon (*Citrus limonum*).

Leaves serrate, oval; petiole slightly winged; branches slender and often spined. Flower of medium size, with a reddish tint outside, but white inside. Fruit pale yellow, generally oval, ending in a nipple-like point, seldom round or pear-shaped. The skin is smooth, and thinner than that of the citron. The tree is small, seldom exceeding sixteen feet in height. It likes a deep, light soil. Though more easily killed by frost than the orange, it will ripen its fruit where the orange cannot, as the latter requires more heat to develop the saccharine matter which it contains. At Auckland, New Zealand, where the orange cannot be said to ripen fully, lemons of good quality are grown, the occasional winter frosts not being sufficiently intense to injure the lemon-trees. At the same time, there seems to be sufficient heat to ripen the lemon, but not enough to fully ripen the orange and develop the saccharine matter of the juice. We may therefore infer that in the southern hemisphere the lemon will ripen as far south as lat. 38°, where the mean annual temperature is 59°.8, and the isotherms for January and July 66° and 52°. Humboldt says it requires a mean temperature of 62°.

The lemon is a most prolific tree, bearing more fruit than the orange. In Sicily a large tree will yield 3000 fruit. The fruit is gathered before it is ripe, which has no doubt the effect of making it bear more regular yearly crops than the orange, and increasing the number of fruit. Mr Moore says he gathers his fruit when about one-third larger than the ordinary lemon of commerce, to allow for it contracting while it is drying. He puts the lemons in latticed boxes holding fifty each, in two layers. The boxes are arranged in a square in a dark curing-room. A brasier of live coals is put in the centre of the square, and an ounce of flowers of sulphur thrown on the coal. The fruit remains thus for a week, when light is admitted till the fruit turns yellow. The effect of the sulphur on both the lemon and the orange is to kill parasites and

fungus-spores, to toughen the skin of the fruit, and dry the moisture it contains.

The lemon begins to bear in about eight years. The cultivation is the same as for the orange. In the south of Europe the most lemons come from Sicily. The fruit is obtainable almost all the year round, but the chief harvest is from October to the end of December. The fruit gathered at the end of the year is said to keep best. Lemons are gathered when green. When the most of the fruit is picked, a few are sometimes left on the tree: these attain to unusual size, and are known as "lustrato." At Sorrento a variety of large rough lemons is allowed to ripen on the trees. Candied peel is made from a large Sicilian lemon grown on higher ground than the most of the fruit, called the Spadaforese lemon. They are gathered, cut in half lengthwise, pickled in brine, and exported. Before candying, the fruit is soaked to get the salt out. Excellent lemons are grown at Malaga.

Oil of Lemon.—Is extracted from green fruit by pressing the rind against a sponge, or by the *écuelle.* An inferior oil is produced by rasping the peel of the fruit and distilling with water. One hundred fruit should yield from two and a half to three and a half ounces of oil. The lemons are sometimes scarified and thrown into hot water, and the oil skimmed off.

Citric Acid.—Is obtained from lemon-juice by saturating it with chalk or whiting till effervescence ceases, by which citrate of lime is formed. This is precipitated, the supernatant liquid run off, and the precipitate well washed. The precipitate is then treated with dilute sulphuric acid: sulphate of lime and citric acid are the results. The former sinks, and the clear solution is evaporated in leaden boilers and then crystallised —the crystals being purified by being again dissolved and recrystallised.

Lime (*Citrus limetta*).

The juice of this fruit has become an article of great importance in late years. The valuable properties it possesses as an

anti-scorbutic are well known. The greatest quantity is obtained at Montserrat, in the West India Islands. The Montserrat Company use only the fully ripe fallen fruit. These are collected in the morning, brought in, and sorted. The sound fruit are treated by the *écuelle* for the oil in the rind; they are then put in a hopper with a sliding bottom, and supplied to two gun-metal rollers having teeth of different lengths, which tear them to pieces; the torn fruit falls on a copper sieve below. After passing through this strainer, the juice is run into puncheons. The pulp is put in coir bags, and pressed in a screw-press to extract the remainder of the juice; the marc is used as manure. The fruit may be treated on a small scale in an American cider-press. Lime or lemon juice is often evaporated to a density of about 1.234, when it contains about thirty-two per cent of citric acid, and is then exported to Europe.

The lime is a straggling bush or tree, about ten feet high. The fruit is small, round and ovate, or depressed. There are many varieties of which there is no classification, so far as I am aware. The juice has a much more delicate flavour than that of the lemon. It is one of the most agreeable items in the cookery of the East and West Indies, a squeeze of fresh lime imparting a most delicious flavour, unobtainable in colder zones. In Ceylon, a small piece of rind of lime is put in finger-glasses, and the water becomes most agreeably perfumed. The tree is hardy in the tropics; but is, I fancy, more sensitive to cold than any other member of the Citrus family, except the shaddock. It grows readily from seed. The trees are planted fifteen feet apart, begin to bear in four years, and are in full bearing in about eight years.

Citron (*Citrus medica*).

The fruit is generally oblong, and particularly large, weighing up to, it is said, thirty pounds. The skin is in colour not unlike the lemon, but is covered with warty excrescences, and

very thick. The pulp is less acid than the lemon. The young branches often have a violet tinge. The flowers are purplish outside and white inside; leaves subserrate. Risso divides citrons into three classes:—

1. "Poucires," large tubercled fruit, oval or oblong.
2. The citrons proper, of a conical shape and swollen look, more or less striped or furrowed, highly scented, and used for preserving.
3. "Cedrats-limons," more like lemons in appearance.

The citron grows to about twenty-eight feet high.

In Corsica citrons are extensively cultivated. Deep rich soil, of a limestone or granite origin, is chosen in the sheltered valleys. Cuttings, sixteen inches long, are taken from branches about a year old, with an inch or so of older wood at the base. These are struck in the nursery, or planted out. The trees are planted fourteen feet apart, and are generally irrigated. The planting season is April. The hole is partly filled with manured earth; the plant, or cutting, is then put in its place, so that the head is not above four inches over the level of the ground. The earth is pressed tightly where cuttings are planted. The action of wind is so hurtful to the citron, that they are not allowed to grow higher than four and a half feet. They are trained into bush shape or vase shape, the branches being supported on spars placed either upright or in a circular shape. The latter way is better explained thus: Some ten or twelve stakes are driven into the ground in a circle round the tree; to these are tied tough wands, so as to make a circular fence of three rails. The lower branches are trained over the lower rail, which supports them; the intermediate branches rest on the next rail, and the higher branches on the top rail. The branches do not project far beyond the rails. The branches are pinched, so as to send as much sap as possible into the bearing wood. The spines are removed. The trees are kept highly manured, the adult trees receiving every year five and a half hundredweight of manure in two

applications. The most perfect shelter from cold winds is required, the citron being one of the most delicate of all the orange tribe. The ground is lightly tilled round the trees twice a-year. At two or three years the citrons begin to bear; at five years they give ten to twelve pounds of fruit; at seven or eight years they are in full bearing, when the produce should be ninety to a hundred pounds weight of fruit, worth about £1. In Corsica the fruit ripens about the end of the month of October. The fruit are gathered before they are perfectly ripe.[1]

In India citrons are often grafted on the pomeloe or shaddock stock. In Assam a branch of the citron bearing a young fruit is bent, and the fruit is put inside a narrow-necked chatty. When ripe, the chatty is broken, and the fruit is said to be of extra size and flavour.

The peel of the citron is candied, and used in cooking.

Oil of Cedrat is obtained from the yellow rind of the citron either by expression or distillation. The first oil that comes over by the latter process is colourless, the last oil is greenish —specific gravity .847. One hundred citrons yield nearly one fluid ounce pale, and half fluid ounce green oil.

Oil of Citron-flowers is amber-coloured, and very fragrant. Sixty pounds flowers yield one ounce oil.

Pomeloe or Shaddock (*Citrus decumana*).

Leaves large; leaf-stalk markedly winged; fruit large and round, with a smooth yellow skin, and weighs up to twenty pounds. This fruit is known by the first of these names in the East Indies, and by the last in the West Indies, where it was introduced by Captain Shaddock, from China, early in last century. A smaller variety of this fruit is called "Forbidden fruit."

The flavour of the shaddock is not very good. It is greatly improved by skinning it for a fortnight before it is eaten.

The skin makes most excellent marmalade and very good bitters.

[1] Du Breuil, Arbres et Arbriseaux.

Risso mentions it as growing at Nice and Paris; but at Paris it was more or less protected, we may infer. It is plentiful at Naples.

It makes an excellent stock on which to graft the sweet orange, the result being an orange of particularly good flavour.

A dressing of salt to the roots of the pomeloe improves the flavour greatly.

Like the rest of the family, the rind and flowers furnish essential oil of considerable value.

The shaddock is the most tender of all the plants of the Citrus family, and is essentially a tropical fruit.[1] In Jamaica and Ceylon it grows up to 2500 feet elevation.

Kumquat (*Citrus Japonica*)

is the hardiest member of the Citrus family. It is largely cultivated in China and Japan, growing freely in situations where the cold of winter would prove fatal to the other species of Citrus. It ripens about Auckland, New Zealand.

Kumquats grow to a height of from three to six feet. They are planted in rows four feet apart, with the same distance between the trees. In China the fruit ripens late in autumn, when it is about the size of a walnut. It is grafted on a prickly wild Citrus stock, which is very hardy. It does not succeed when grafted on the common sweet orange. Two varieties of kumquat are known, the fruit of one being small and round, that of the other being larger and oval. The fruit is well known as a Chinese preserve. It is a perfect orange in miniature, the flavour being pleasant but slightly bitter. It would be a useful plant to cultivate in countries where the larger oranges do not come to perfection.

The stock of the wild species, upon which the kumquat is grafted, is said to be uninjured when the thermometer sinks as low as zero; consequently the Department of Agriculture for the United States has recommended its trial in those States where the orange is apt to suffer from the frosts of winter.

[1] See p. 36.

The export of oranges and lemons is an important branch of trade in South Europe, as will be seen by the following table :—

	Portugal.	Spain.	Italy.
1882	155,418,000 £92,025	£1,166,680	119,439,000 kilog. £1,098,840
1883	100,627,000 £44,100	£868,320	158,557,000 kilog. £1,268,440
1884	98,055,000 £40,725	£975,680	173,252,000 kilog. £1,386,000

The Portuguese returns give the number of oranges exported ; besides which, the exports from the Azores, Malta, Palestine, &c., are very large. In 1875 the value of the oranges and lemons exported from Greece was £28,920.

Florida is extending the cultivation of oranges and lemons to an enormous extent, and the Jamaica export is steadily increasing. Fiji is exporting fruit to New Zealand and Australia. And the growers in New South Wales and South Australia have a ready market for their surplus fruit in the other colonies.

The following table will give an idea of the value of the trade to the United Kingdom in oranges and lemons :—

	1880.	1881.	1882.	1883.	1884.
Imported,	Bush. 3,658,799	3,835,103	4,220,427	4,477,043	4,944,535
Value,	£1,463,019	1,467,562	1,659,367	1,704,826	1,776,057
Exported,	Bush. 456,569	399,603	500,843	607,178	584,161
Value,	£194,635	161,830	199,175	237,961	199,324

ALMOND (*Amygdalus communis*).

Nat. Ord. Rosaceæ.

Belongs to the same genus as the peach and plum. Is a small tree from fifteen to twenty-five feet in height, with oblong lanceolate and serrated leaves. The fruit (fig. 3) is a drupe, of ovate form, covered with a downy epicarp, inside of which is a fibrous mesocarp which surrounds the shell containing the kernel. The flowers appear very early in

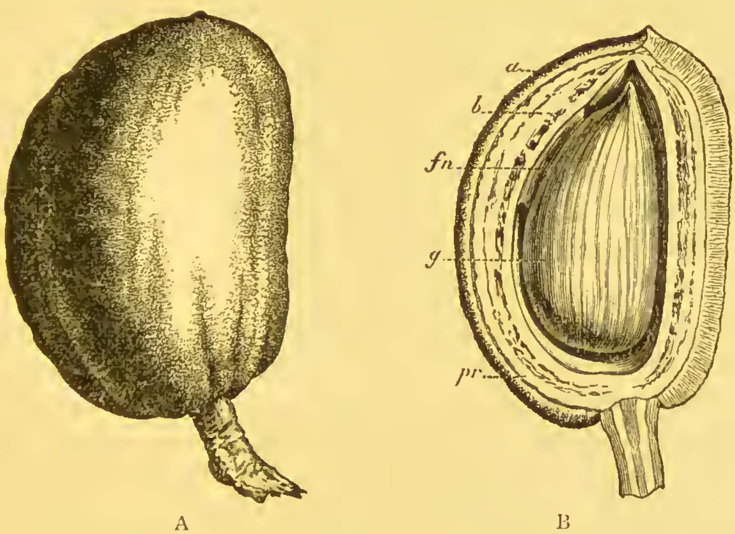


Fig. 3.—Fruit of Almond (*Amygdalus communis*, L.) A, Entire fruit. B, Longitudinal section: *a* Epicarp; *pr* Mesocarp; *b* Stone or *putamen* (endocarp); *g* Seed; *fn* Funiculus.

spring, before the leaves open, and are in consequence often destroyed by frost; they are of a fine pink colour.

The almond is thought to be a native of Persia and the north coast of Africa. It grows over the greater part of South Europe, and in Palestine, Syria, the Canary Islands, and North China. It thrives wherever the olive grows, and will even grow as far from the equator as the limit of the vine; but owing to the blossoms appearing in early spring, they are

generally killed by frost, and the produce of the tree cannot be depended upon.

In North America it shows fair results in Florida, and succeeds admirably in California. In Georgia it is apt to blossom too early, and is often destroyed by sudden frosts: for this reason it is said to show better results in Pennsylvania, where the blossoms are later in appearing.[1]

It should do remarkably well in Australia and New Zealand. Where the climate is too warm, and vegetation is continuous all the year round, the almond does not produce fruit; in this it shows a marked resemblance to the olive. It fruits occasionally in England, but the produce is very inferior.

The geographical range of the almond in the northern hemisphere is between the twenty-seventh and forty-fifth parallels of north latitude; within these bounds the tree can be successfully cultivated. An annual mean temperature of from 58° to 66° suits it admirably, provided there are no frosts in the early part of the year to injure the blossoms.

The almonds most in favour in the London market are the "Jordan almonds" from Malaga, which fetch from 160s. to 285s. a hundredweight; Valencia, 100s. to 120s.; Sicily, 102s.; Barbary, 60s. to 90s. Of bitter almonds the French are largest, then Sicilian, and next Barbary. The value is from 60s. to 85s. a hundredweight.[2]

Almonds do not thrive in soil which is too heavy or too light. A deep, warm, dry soil, mixed with small stones, suits them best, as the roots penetrate deeply in the ground. They prefer a rather dry climate. They stand wind; so may be planted on the slope of a hill, where they are less likely to be attacked by frost than is often the case when they are grown on low ground.

To grow from Seed.—Stratify the finest almonds in wet sand in November. In April plant them two inches deep in light rich earth. The seeds should be one foot and a half apart,

[1] Johnson's Cyclopædia.

[2] Encyclopædia of the Industrial Arts.

with two feet between the rows. At the end of the same summer they may be budded at the foot with a dormant bud, placed about four inches above the surface of the earth. In the following spring cut the plants back to within four inches above the graft, and plant them in their permanent situation in autumn. If the trees are to be standards, they are grafted a year or two later in September, when the sap has somewhat diminished, as the grafts will not take when the sap is in full flow. The grafts should be taken from mature trees and from fruit-bearing branches. The almond is usually trained as a standard, half standard, or pyramid, and receives much the same treatment as the apricot. The almond should be always grafted on its own stock; and it is better not to graft the sweet almond on the bitter, though this is done in France. The head of the standard tree should be trained to a goblet shape. The tree must be pruned yearly, no matter what shape is adopted, all gourmand branches being removed and the ends of the primary branches shortened, as, if left to itself, it would run too much to wood. The same treatment adopted for the peach may be applied to the almond.

To ensure good crops of almonds, manure must not be spared. When the tree begins to languish, owing to overbearing, age, or any other cause, the soil must be well manured, and in autumn the trees must be most heavily pruned, cutting back the primary branches to half their length if necessary. In the event of the branches being thus cut back, it will be necessary to re-form the head of the tree.

In Italy the almond begins to bear at four years old, and is in full bearing at about fifteen years or more, and seldom begins to fail till sixty years of age. When the fruit is ripe the pericarp opens. The fruit is knocked off with light rods, the well-known reed *Arundo donax* being generally used in South Europe. The fruit is collected, and prepared for market by removing the outer coverings. The yield of a tree in France is about six kilogrammes (13½ lb.) of shelled almonds, which sell locally at one franc the kilogramme. In

California a tree bears about twenty pounds of almonds, and the produce of an acre is worth £100.[1]

The following are the favourite varieties most commonly cultivated :—

Common sweet.—Commune. Douce, à petits fruits. Fruit from one and a quarter to one and three quarter inch long. Skin pale green, covered with a thick down. Stone hard and thick, grooved like that of a peach. Kernel sharp at the ends, and sweet. A handsome tree. Ripens about the end of August.

Large sweet.—Long hard shell, à gros fruit, douce à coque dur. Fruit about two inches long by one and a quarter broad, the point ending in a nipple, and one side having a deep suture; the whole covered with down. The shell is thick and hard, enclosing a kernel about one and a half inch long, which is sweet and of excellent flavour. Ripens early in October.

Pisache.—A small, blunt-pointed fruit, one and a quarter inch long, covered with fine down. The shell of the kernel resembles a pistachio in size and shape, and encloses a sweet, pleasant kernel. Much grown in South France.

Fig. 4.—*Amygdalus communis*, var. *amara*—The Bitter Almond.

Sultana. — Larger than the last. Kernel sweet and well flavoured.

Tender-shelled. — À coque tendre, paper-shelled. Fruit oval in shape, one and a half inch long by one inch across, one side convex, while the other is nearly straight. Shell fibrous, containing a large sweet white kernel. Ripens in August. This is the variety sold as "Jordan almonds."

There are similar varieties of the bitter almond (fig. 4).

Almond-oil is of considerable use in medicine and the arts.

[1] Johnson's Cyclopædia.

There are two separate oils extracted from almonds. The first is a clear fatty oil, almost devoid of taste and odour, and useful for all the purposes to which fine oil is put. The second is an essential oil employed in perfumery. The first oil is extracted from both the sweet and bitter almonds, the latter being deprived of their skins. The almonds are crushed, put in bags, and pressed. One hundredweight of almonds yields forty to forty-five pounds of oil. It is often adulterated with cheaper oils. It is used in medicine and by perfumers, being well adapted for purposes of enfleurage or extraction of scents (see p. 51). The essential oil is not met with naturally in the kernel, but is produced by the decomposition of amygdaline in water. Bitter-almond kernels only are used. These are crushed and pressed to extract their fatty oil; the paste or refuse is then mixed with fresh or salt water till it assumes a creamy consistence. It is allowed to stand in the still for twenty-four hours, to allow the emulsion to decompose the amygdaline. It is then distilled as long as the distillate is milky turbid. The yield of oil is about one per cent. It is used in flavouring, and is harmless if pure, but impure oil may cause poisoning.[1]

The composition of oil of bitter almonds is :—

Carbon, ...	79.24
Hydrogen, ...	5.66
Oxygen, ...	15.10[2]

The exports of almonds from Spain and Italy in the years 1883-84 were :—

	Spain.	Italy.
1883	3,341,000 kilog.	6,334,000 kilog.
	£180,320.	£253,360.
1884	3,269,000 ,,	9,331,000 ,,
	£169,300.	£373,240.

[1] Royle, Materia Medica.

[2] Johnston, Chemistry of Common Life.

DATE-PALM (*Phœnix dactylifera*).

Nat. Ord. PALMACEÆ.

A native of North Africa, the very south of Europe, Arabia, and the East, from Palestine to India. The geographical bounds of the date-palm in Europe and Asia Minor are: Portugal, in Lower Estramadura (lat. 38° N.); Spain, in Andalusia, from Murcia to Alicante (33° 28′ N. lat.); Valencia (39° 21′ N.); and at Oviedo (43° 22′ N.) they ripen occasionally. Nice is the only place in France where the fruit has ripened, but it rarely does so; and the same may be said of Bordighera and Genoa, in Italy. Even in the south of Italy, though the date-palm bears fruit, yet it seldom ripens. In the south of Sicily it ripens its fruit in unusually hot years. At Tarsus, in Asia Minor (lat. 36° 54′ N.), notwithstanding the great heat of summer, it does not ripen.[1] At Sidon (33° 33′ N. lat.) it is one of the fruits of the country. The northern limit of the date-palm may therefore be said to be lat. 33°, south of which it ripens till it is stopped by the moisture of the tropics.

The date-palm (fig. 5) is a handsome tree, with the usual tall straight stem of its class, surmounted at the top with a tuft of feathery pinnated leaves of a deep green colour, and from nine to twelve feet in length. The height of the tree varies according to locality and circumstances, but is usually from forty to eighty feet. The wood is fibrous and tough. The tree lives to a great age, producing fruit till it is 200 years old. These palms are diœcious, the male flowers being larger than the female. It is therefore necessary to observe the sex of the trees; consequently the Arabs prefer propagating by suckers taken from the base of a female tree, rather than growing plants from seed, when the sex of the trees would be doubtful. It is said that although the wild palms fertilise themselves, the

[1] Encyclopædia Britannica.

cultivated tree requires artificial impregnation with the pollen of the male plant. The seed takes at least six months to germinate; but the plants thus raised are thought to be inferior to those grown from suckers. The propagation is effected by taking a slip from the foot of a female tree, which must be watered every day for the first few weeks, the supply of water being gradually diminished till it is supplied only once a-week. They bear fruit in seven years, but do not bear fully till they are twenty years old. In Algeria the trees are not usually preserved for fruits after they are 100 years old, but are then tapped for the sap, or toddy, which is made into palm-wine, or *lagbi*. The process is simple. An incision is made in the crown of the tree, and the sap flows through a piece of hollow bamboo into a vessel suspended just below the wound. A gallon of toddy is obtained every day for the first fortnight, after which it gradually lessens, and ceases in six or eight weeks' time; but such continuous bleeding kills the tree. When the sap is moderately drawn off, the process is beneficial rather than hurtful to the tree. Like the toddy of other palms, the sap thus obtained is a sweetish pleasant beverage in the early morning; but the heat of the sun soon causes fermentation,

Fig. 5.—*Phœnix dactylifera*—The Date-palm.

when it becomes sour and intoxicating. It may be boiled down into sugar, like the jaggery of India, while still sweet and fresh, or distilled into arrack after fermentation.

Although the date-palm requires a hot dry climate, yet its roots must have access to moisture. It is essentially a tree belonging to desert regions, yet it is confined to the oases in these deserts where water is found. It flourishes in rainless countries, but only where there is moisture in the soil, either naturally or produced by irrigation.

There are many varieties of this palm; in the oasis of Ziban alone ninety are found.[1] The yield of a tree in full bearing is from one hundred to two hundred pounds weight of dates annually, but as much as four hundred pounds of dates have been got from a single tree. A tree generally produces from eight to ten bunches of fruit, and the produce of a hectare (2½ acres) of land under this cultivation is about 14,400 pounds of dates.

The fruit is gathered before it is quite ripe, and dried in the sun to make it keep, and is then sent to market; for the fresh dates soon ferment, and cannot be kept for any length of time. The value of dates in England is: Tafilat, 70s. to 84s. a cwt.; Egyptian, 28s. to 45s.; Bussora, 13s. to 21s.

The uses of this palm, apart from the fruit, are numerous. The bark yields a fibre which is used for ropes, matting, baskets, and sacks. The leaves are used for thatching, basket-making, and fibre for cordage, &c. The foot-stalks are used for fuel and for fencing. The timber is easily split; it takes a good polish and makes good posts. The roots are used for fences and roofing. The unripe fruit can be used for vinegar-making. The ripe fruit, as we have already seen, yields spirits and sugar, and when pressed yields a most pleasant syrup. The stalks of the leaves and stones of the fruit may be softened by boiling, and used for feeding cattle.

The date-palm should be extensively grown in Australia. Were it planted in suitable places in the deserts in the interior

[1] Murray, Algeria.

of that continent, it would some day be found of as great value as it is now in the Sahara. A supply of seeds should be sent with every expedition to the interior, and every means taken to disseminate a tree of such value.

FIG (*Ficus carica*).

Nat. Ord. MORACEÆ.

This is one of the oldest cultivated fruits on record. It is probably a native of the eastern Mediterranean regions, but is now so widely spread throughout the warm-temperate, sub-tropical, and northern tropical zones, that it is a difficult matter to hazard any conjectures as to its original source. It grows in the plains of North-West India, on the Himalayas to an elevation of 5000 feet, Afghanistan, North Persia, Asia Minor, Palestine, North Africa, and the warmer parts of Europe, ripening its fruit in sheltered situations in the south of England. It is naturalised in Australia, the North Island of New Zealand, California and other parts of the United States, and Chili.

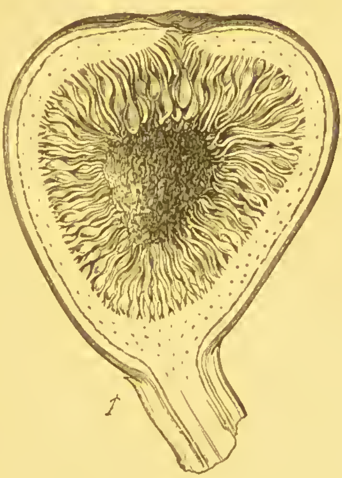


Fig. 6.—Longitudinal section of the Fig (*Ficus carica*), showing the fruits enclosed by the fleshy conceptacle, which is only an enlargement of the peduncle (*p*).

The fig is a deciduous tree, growing to a height of from fifteen to thirty feet. It requires about the same degree of temperature as the olive to ripen it to perfection, but will ripen its fruit where the olive could not.

The edible part of the tree is not really a fruit, but is the

hollow receptacle containing the flowers, in the pulp of which the seeds are buried (fig. 6). The flowers are very small and unisexual, the male flowers occupying the upper and the female flowers the lower part of the cavity (fig. 7).

The fructification and vegetation of the fig is uninterrupted where the mean temperature does not sink below 53° F.; but

Fig. 7.—Fruiting branch of the Fig (*Ficus carica*). *a* Fig cut longitudinally to show the collection of flowers inside the "cœnanthium"; *b* One of the staminate flowers; *c* One of the pistillate flowers; *d* Ripe fig (syconus) cut open to show the collection of fruits; *e* One of the fruits; *f* Seed with embryo.

where the temperature descends below this mean, the leaves fall, and the fruit presents a curious phenomenon. A branch only develops, and ripens part of the figs borne upon it—those on the lower end nearest the stem. The immature figs at the farther end of the branch have their growth arrested by the

first cold weather, and remain dormant during the winter, resuming their growth the following spring, and ripening in the summer. These are known as "first figs" or "summer figs." Those which commence their formation in spring on the lower part of the branches are called "second figs" or "autumn figs." In warm climates there are thus two crops from the same tree every year. In colder climates the "first" or "summer" figs form the whole crop, as autumn figs can only be produced in unusually warm seasons. In a warm climate the autumn crop will yield most figs, which are sweeter, less watery, and better suited for drying than summer fruit, these last being generally eaten fresh.[1]

Fig-trees are easily propagated by layering in the autumn or early spring. Choose a branch near the ground, remove a little of the bark of the layer at a joint on the top side, which is to be buried, to check the flow of sap and force it to strike. As figs do not stand transplanting well, it is better to layer them in pots or boxes of soil, which facilitates the operation. Suckers are easily propagated in autumn, but plants reared from them are apt to beget more suckers. Cuttings should be made from ripe young branches, and cut above and below a joint. They are generally about nine or ten inches long, of which only about two inches should project above the soil when they are planted. Each cutting should have a heel of old wood at its base. They should be planted in their final resting-place when the climate is mild, or struck in pots in colder climates. Fig-trees are only grafted when the fruit is inferior—the grafts usually employed being ordinary cleft, crown, or flute grafting.

In the south of France fig-trees are usually planted in single lines among other fruit-trees, on account of their liability to be attacked by a fungus which often proves fatal to whole plantations.[2] The fig should only be grown as a standard where the winters are mild, as it is necessary to protect them as much as possible from frost. In very dry climates, standards

[1] Du Breuil, Arbres et Arbrisseaux.

[2] Du Breuil.

are apt to suffer from drought, and are consequently generally grown as suckers from stumps, so as to shade the roots as much as possible from the sun. A French proverb alluding to the necessity of moisture for this tree says, "The fig must have its roots in the water and its head in the sun."

Standard trees are allowed to grow unchecked for two years. In the spring of the third choose the strongest branch, remove all others, and cut the stem off a few inches above the branch selected. To the piece of stem left this branch must be tied, and only the terminal bud is left upon it until it has attained the desired height, about eight and a half feet, when the terminal bud is removed, and the lateral branches trained to form a neat head.

At Argenteuil, near Paris, where, owing to the frosts of winter, the fig cannot be grown as a standard, it is grown by suckers springing from a stool. The soil is deeply cultivated and highly manured. The varieties most grown are *Blanquette* or *Coucourelle blanche.* The layer is planted with eight or nine inches of the stem buried obliquely, sometimes two layers being planted close to each other. The trees are ten feet apart in lines, with nine feet between the rows. During the first summer the plants grow unchecked. In November, after the leaves have fallen, the young stem is bent over and covered with earth to protect it from frost. The covering with earth is unnecessary, as the plants would be just as safe were they pinned close to the earth, and treated as vines are on the Rhine. About the 1st of March the buried shoots are uncovered, and by the middle of the same month the shoots are topped to half their length to promote the growth of suckers. Every winter they are buried as before in a cruciform shape, to suit the direction in which the suckers bend easiest. The branches are trained well apart, so as to keep the leaves from rubbing against and damaging the fruit. Fourteen to sixteen shoots are allowed to spring from one stock. The fourth year they begin to bear, and the terminal bud of the primary branches is removed, also half the wood-

buds. Two buds at the base of each branch are preserved, as is one at the point of the branch. When the branches bear too heavily, the fruit must be thinned, leaving about five figs to each branch.

Figs contain so much sugar, that they may be preserved by simply drying them in the sun, the fruit being exposed on wicker trays. At night they are put in a dry room free from any bad smell. In dry climates the figs are only covered with waterproof cloths. When the figs can be flattened without splitting, they are sufficiently dry. Natural figs are allowed to dry in their proper shape without flattening, the latter process necessitating an unpleasant amount of handling. The best figs are labelled "eleme," being the Turkish for "hand-picked." Inferior figs are pressed into cakes, and sold as fig-cake. Alcohol may be distilled from the ripe fruit. A fig cut open forms a common cataplasm for wounds and boils. A demulcent drink, useful in affections of the throat, may be made from them. Medicinally the fruit is a gentle laxative. A piece of the wood of the tree, sprinkled with emery powder, may be used as a hone. The value of figs in the London market is about 20s. to 24s. a cwt. for Spanish, and 33s. to 100s. a cwt. for Turkish layers.

Much has been written in favour of caprification, or hanging bunches of wild figs over the cultivated, to allow hymenopterous insects to drop on the cultivated trees. The puncture which these insects make distributes the pollen, and is said to aid fertilisation; but the process is going out of use, and seems to be quite unnecessary, though the same effect is gained by a curious old French plan. A fine straw is dipped in olive-oil and applied to the centre of the eye at the base of the fruit. This is usually done after sunset. The effect is to swell and ripen the fruit, which may be picked four days afterwards. The flavour of the fruit is much improved by this singular process.

The export of figs from Portugal in 1883 was 9,088,000 kilogrammes, valued at £82,125; and in 1884 the export was

5,394,000 kilogrammes, worth £48,825. Greece in 1875 exported 30,837,945 lb., valued at £146,400; the average exports are probably about £85,000.

Professor Johnston calls attention to the nutritive nature of the dry fig, and compares it with wheaten bread:—

	Fig.	Wheaten Bread.
Water,	18½	40
Gluten,	6	7
Starch, sugar, gum,	66	51
Mineral matter,	2½	1½
Fibre,	7	½
	100	100

JUJUBE (*Zizyphus vulgaris*).

Nat. Ord. RHAMNACEÆ.

Originally a native of Syria, this tree has become naturalised along the shores of the Mediterranean. The principal requirements of the jujube are bright sunshine and a certain degree of solar heat. In France it only fruits freely in the extreme south, but it may be seen growing as far north as lat. 47°. It requires much the same climate as the carob. Though it will grow on dry arid soil, yet it prefers light fresh land, and in favourable situations attains a height of twenty-five feet.

It is best propagated by means of the suckers which shoot from the foot of the tree, as the seeds take two years to germinate. The suckers are kept in the nursery till they attain a height of four feet, when they are planted out in rows twenty feet apart. The jujube is a very slow tree in coming to maturity, not giving much return till it is from twenty to thirty years old. The only cultivation given is stirring the soil, the occasional application of a little manure, and very slight pruning.

In the United States it is in favour as an ornamental hedge-plant, owing to its shining dark-green leaves and thorny

branches. It thrives south of lat. 38°, and is said to grow rapidly.

The fruit resembles the confection called after it, and is commonly seen in boxes of crystallised fruit, being red in colour, and somewhat resembling a cherry. In France ten kilogrammes of dry fruit, worth one franc the kilogramme, have been got from a tree. The fruit are pulled, to eat fresh, when they redden, but they must be allowed to ripen fully if they are to be dried.

PISTACHIO (*Pistacia vera*).

Nat. Ord. ANACARDIACEÆ.

A native of Syria, introduced into Italy in the reign of Tiberius, from whence it has spread over Southern Europe. It grows to greatest perfection in Sicily and Northern Africa, but is quite at home in the south of France; it will even ripen its fruit in the middle of France if grown against favourably exposed walls, especially when it is grafted on a terebinth (*P. terebinthus*) stock, which makes hardier trees. The climatic conditions requisite for the olive apply also to the pistachio—viz., a mean temperature between 58° and 66°; the mean of the coldest month not being under 41° F., nor the mean of the warmest month under 71° F.

Pistacia vera is a diœcious tree, attaining a height of twenty or twenty-five feet. The fruit, which grows in clusters, is an ovate drupe, of the size and shape of an ordinary olive. When ripe it is of a yellow colour dotted with white, but red on the side exposed to the sun. The pulp is thin, and of a pale-crimson tint. The stone splits in two when ripe, and contains a bright green kernel of most delicate flavour, covered with a reddish pellicle. The fruits, which grow near the ends of the

branches, have the sides grooved: the terminal points when straight are said to indicate male seeds; while those with smooth surfaces and the terminal points bent on one side, are said to produce female plants.[1]

The plant is propagated by seed or by layers; but the former way is preferable, and gives hardier and longer-lived trees. They flower at about twelve years old, when the male and female trees can be recognised. One male tree should be allowed for six female. If the trees prove to be all female, a bud from a male tree may be grafted on the lower part of the stems of the female trees. In Sicily the custom is to suspend a branch with male flowers over the female trees to fertilise them. The flowers are apetalous and borne on racemes. The male flowers are small, five-parted, and have a stamen to each segment. The female are three or four parted, enclosing a celled ovary.

If the trees are to be grafted, the best stocks are those of the terebinth (*P. terebinthus*). The stocks should be an inch and a half in diameter before they are grafted, and the graft placed about three feet from the ground. The usual plan is to shield-graft them with a dormant bud.

The cultivation of the tree is the same as that usually adopted for the almond, but the pistachio-trees are not pruned. Irrigation does not suit them. When the trees show signs of diminished production, they may be renewed by cutting back the principal branches to ten inches from the stem.[2] The fruit is gathered when the outer skin is deep yellow, and are then dried in the shade.

Pistachio-nuts are eaten when dried, like almonds. In France they are candied, or coated with sugar, and make a most delicate sweetmeat. The green colouring matter in the kernels is quite harmless. A greenish oil of sweet aromatic flavour is extracted from the kernels; but it does not keep long, and is apt to become rancid. The wood is hard, resinous, and of some value: it burns well.

[1] Du Breuil. [2] Ibid.

POMEGRANATE (*Punica granatum*).

Nat. Ord. LYTHRARIEÆ (or MYRTACEÆ).

The pomegranate is one of the fruits brought under cultivation by man at a very early period of history. It is frequently mentioned in the Bible, and gives its name (rimmon) to several places in Palestine. The ancient Phœnicians used it in their religious ceremonies, and Homer alludes to it in the 'Odyssey.' The genus Punica is among the oldest forms of vegetation, a variety having "been discovered in the pliocene strata of the environs of Meximieux." [1]

The pomegranate ripens in the south of France and the countries around the Mediterranean; on favourably exposed walls it will even ripen at Paris; it succeeds in Australia, but nowhere attains the size and perfection which is reached in Persia. It requires a temperature to ripen it similar to those demanded by the pistachio and olive, but it stands a greater degree of heat, ripening on the plains of India and the hills of Ceylon—a dwarf variety (*P. nana*) being naturalised in the West Indies. Moist land does not suit it at all; it grows well on very dry soil, but comes to perfection on strong rich ground.

Pomegranate-trees are usually grown from seed. The trees, after remaining in the nursery for two or three years, are planted out: they may be grafted either before or after transplanting with a dormant bud. The sour pomegranate makes the hardiest stock on which to graft the sweet variety. Layering may also be employed as a means of propagation.

The pomegranate is generally left to grow as it pleases, a practice which is strongly condemned by M. Du Breuil, who advises training them in goblet or vase shape. He also recommends pruning the trees in order to improve the fruit, pointing out that, on unpruned trees, the flowers usually grow at the ends of the branches of medium size, and that the

[1] De Candolle, Origin of Cultivated Plants.

growth of these secondary branches should be encouraged. All suckers from the base of the stem must be removed. The trees should be manured every year, and irrigated during droughts when growing on light soil. M. du Breuil further points out that as the fruits are apt to split in autumn before they are quite ripe, owing to the action of the sun and rain, it is better to tie the fruit-bearing branches into the heart of the tree to shelter them. The fruit keeps well when wrapped in paper and placed in jars of dry sand.

There is a large seedless variety cultivated in Persia which has been overlooked by horticulturists. Furmiger[1] recommends mixing finely broken bricks and well-decayed cow-dung with the soil where this fruit is planted. After bearing, the tree should be cut well in. He further states that the tree must be manured every year.

The pomegranate is an excellent hedge-plant. The beautiful crimson flowers are used as a dye in Barbary. The stem yields a gum. The rind of the fruit contains 13.6 per cent of tannin, and, along with the root-bark, is used in tanning morocco leather. The bark of the root is a most effectual vermifuge, a fact known to Cato. It is prepared by macerating two ounces of crushed bark in two pints of water for twenty-four hours, and then boiling it down to a pint. It is administered after a day's fasting, and is particularly useful in expelling tape-worm. A dose of castor-oil should be administered the day after the root-infusion is taken. An infusion of the rind is useful in cases of diarrhœa; and two ounces of rind, prepared in similar quantities and manner to the infusion of root-bark, makes an effectual injection for leucorrhœa. The bark of the stem contains a large quantity of tannin.

[1] Gardening in Bengal. Thacker, Spink, & Co.: 1874.

THE GRAPE-VINE (*Vitis vinifera*).

Nat. Ord. VITACEÆ.

Among the plants belonging to subtropical and warm-temperate zones, the vine is perhaps the most important. It is a native of the country south of the Caspian Sea, and is the first cultivated plant of which we have any record, Noah having planted a vineyard (Gen. ix. 20). In the eleventh tablet, which gives the Chaldean account of the Deluge, the forty-seventh line of the third column says, "By seven jugs of wine I took," which shows that wine was drunk in antediluvian ages. William of Malmesbury, in writing of the Vale of Gloucester in the early part of the eleventh century, says: "There is no province of England hath so many or good vineyards as this country, either for fertility or sweetness of the grape; the wine thereof carrieth no unpleasant tartness, being not much inferior to the French in sweetness." In Pepys's Diary for 17th July 1667, he says: "For joy he [Sir W. Batten] did give the company that were there a bottle or two of his own last year's wine, growing at Walthamstow; than which the whole company said they never drank better foreign wine in their lives." Whether the climate of England has become cooler and moister with cultivation, against all rules of meteorology, or, more probably, that people in the days of William of Malmesbury and Mr Pepys were content to drink sour wine, certainly at the present day a drinkable wine cannot be made in England.

The vine may be profitably cultivated in Europe between the 35th and 50th parallels of latitude, within which bounds are situated those countries which produce the most celebrated wines—France, Portugal, Spain, Germany Hungary, &c. Beyond the 50th parallel of latitude the fruit is deficient in the saccharine matter required in alcoholic fermentation: the wine, not possessing sufficient alcohol to preserve it, is sour, and more like vinegar than wine. On the other hand,

if the wine is grown in too warm a climate, too much grape-sugar is produced, and the grape gives a thick, sweet, alcoholic fluid of indifferent quality. When the vine (fig. 8) is cultivated in tropical countries, where there is no winter to check its growth, which is therefore uninterrupted, we find it producing on the same cluster flowers, and both green and ripe fruit, in

Fig. 8.—*Vitis vinifera*, L. (the common Grape-vine). *a* Fruiting branch, with *b*, the tendril; *c* Flower-bud; *d* Section of pistil showing the bilocular ovary with two upright ovules; *e* Flower showing the caducous petals united at the apex and separating at the base, with the disc surrounding the base of the ovary; *f* Andrœcium and gynœcium, with the small almost entire calyx, and the disc. The corolla has fallen.

consequence of which wine-making becomes impracticable.[1] It is, however, interesting to remark, that vines have borne tolerably good grapes at Jaffna, in the north of Ceylon (lat. 9° N.), where the mean annual temperature is 82°—the maximum temperature being 92° and the minimum 65°,—the

[1] Du Breuil, Les Vignobles.

custom at Jaffna being to bare the roots during the dry season in order to check vegetation and arrest the flow of sap, causing similar effects to those produced by the cold of winter in more temperate latitudes. When the leaves fall, the earth is replaced.

In considering the degree of latitude farthest from the equator which permits the cultivation of the vine being successfully attempted, a leading French authority, M. du Breuil, Professor of Arboriculture at Paris, writes: "Deep valleys, sheltered from cold winds, allow vines to be grown beyond the degree of latitude where the cultivation usually ceases. The deep and sheltered valleys of the Moselle and Low Rhine, situated at the extreme limit of the climate necessary for vines, still produce excellent wines. But this region is far from the sea, and has a continental climate characterised by a dry atmosphere and a temperature which, although cold in winter, is very hot in summer—conditions most suitable for vineyards. On the contrary, other countries situated within the limits given before, but nearer the sea, have abandoned the cultivation of the vine, because they are exposed to the humidity of the winds from the west and south-west, which prevents the ripening of the grape by prolonging the vegetation of the vine. This marine climate also shows this peculiarity, that the winters are mild and the summers very temperate. This is the case in part of Normandy and the peninsula of Brittany." Grapes grown under the latter conditions are invariably of poor quality, and generally sour. Where the atmosphere is usually moist and cloudy, grapes do not ripen well, although the yearly isotherm may indicate sufficient heat to ripen them properly. The tendency of the vine in such a climate is to run so much to wood that the fruit is insufficiently nourished. This is more particularly noticeable in the colder limits of vine-culture.

The climate suited for vine-cultivation must have plenty of light and sunshine; the air must be dry and free from humidity; and the rainfall must not be too great, for the vine likes a dry soil. At the time when the vine flowers the weather

should be warm, still, and dry—though, before that, a moist forcing spring is necessary. When the grape begins to swell, and till it ripens, clear, warm, dry weather is best. When the time arrives for gathering the grapes, the weather must be dry and hot. In a cold season, or when fogs and high winds prevail, the grapes will be very inferior. Should the season be wet and rainy while the grapes are ripening, they will prove deficient in saccharine matter and flavour, and the wine will be poor and thin. From a series of experiments upon vines in Alsace, Boussingault found that from April to October—the season the vine is maturing its fruit—the mean temperature should be 61°. Early vines require least heat, and are consequently better suited for countries where the temperature is low, late vines being better adapted for countries which have high temperatures.

Insular climates are not as a rule suitable for vine-cultivation, as the temperature is too equable and the atmosphere humid to excess, which forces the vine to make wood. It is for the above reasons that the wine of the Azores is inferior and deficient in sugar. On the contrary, islands with dry climates produce good wine. Humboldt mentions magnificent grapes growing at Astrakhan, lat. 46°.26 N., where the mean temperature is 48°—the mean summer temperature being 70°.2, and the cold in winter lowering the thermometer to 22° F. This proves how well the vine is able to withstand a short winter of great severity, provided the other seasons are genial.

In South America vines grow as far south as lat. 37°; the wines of the Cape of Good Hope are well known; while the insular climate of New Zealand, though apparently not so well suited for vine-growing in the north, admits of wine being produced in Otago, in lat. 45° S., where the winter frosts check the growth of the vine at that season—and I hear, from good authority, that the wine is of excellent bouquet. About Wanganui (lat. 40° S.) vine-cultivation has made more progress than anywhere in New Zealand, and a small quantity of wine has been made.

Humboldt gives the following table of comparative temperatures of different wine-producing places with those of places where no wine is grown :—

Locality.	Latitude.	Altitude.	Mean Temperature of Years.	Mean Temperature of Winter.	Mean Temperature of Spring.	Mean Temperature of Summer.	Mean Temperature of Autumn.	Number of Years of Observation.
			°	°	°	°	°	
Bordeaux, . . .	44°50′	25	57	43	56.1	71	58	10
Strasbourg, . . .	48 35	479	49.6	34.2	50	64.6	50	35
Heidelberg, . . .	49 24	333	49.4	34	50	64.2	49.8	20
Mannheim, . . .	49 48	300	50.6	34.9	50.8	67.1	49.6	12
Würzburg, . . .	50 07	562	50.2	35	50.4	65.7	49.4	27
Frankfurt-on-Main,	52 31	383	49.4	35.3	50	64.4	49.4	19
Berlin, ...	49 39	102	47.7	31	46.7	63.5	47.5	22
Cherbourg, no wine,	53 23	...	52.1	41.4	50.8	61.7	54.3	3
Dublin, "	53 23	...	49.1	40.2	47.1	59.6	49.7	13

The wines of Australia are not so much drunk in England as they should be. Being naturally strong full-bodied wines, they are obliged to pay a higher rate of duty in England than the light French wines. This is much to be regretted, as their quality is excellent, and they are pure and genuine wines. The heat of the Australian summer accounts for their strength, and they therefore require no admixture of alcohol to ensure their keeping. The cultivation is now better understood, and wines of every variety are produced. It puzzles many a visitor to these colonies why inferior foreign wines are used at all, when the Australian wine is in every way superior to the imported. The cultivation of the vine is chiefly confined to the colonies of South Australia, Victoria, and New South Wales, Queensland showing a marked decrease, as the climate there begins to be too hot for wine-growing. Thus in the southern hemisphere the grape-vine seems to be confined between the limits of latitude of from 28° S. to 46° S., though both these extremes must be considered rather excessive.

In North America the wines of California are of very high quality, and the industry has become a large one. Missouri

also produces excellent wine; and some of the other States have turned their attention to this industry, for which their climates are well adapted. It is usually said in the United States, that wherever maize will ripen grapes can be grown. As regards the temperature required by vines, this is probably the case; but grapes require further climatic conditions before they can be said to ripen to perfection.

One of the great hindrances to the cultivation of the grape is the presence of mildew, which may attack either the fruit or the foliage. Mildew is caused by a damp atmosphere and heavy dews: when these are absent, the climate is suited for the cultivation of vines. But the most necessary condition for the production of good grapes is in having plenty of direct sunlight, not interrupted or diffused by intervening clouds.

Marié-Davy found that during the period preceding maturation the acids leave the leaves and other green parts of the plant, and collect in the grapes; but when the grape begins to soften, and lose its green colour, the acids which it contains begin to diminish, and continue to disappear till the grapes are fully mature. The decrease of these acids is greater, and the process accelerated, under a clear bright sky, where the solar rays have direct power; but on the other hand, a dull cloudy sky arrests or retards the diminution of these acids. This explains why the quality of grapes depends upon the weather which prevails in August and September. This is easier to understand from the discovery of Polacci that the grape commences to ripen at the very outside just below the skin, and extends internally—which shows that the part of the grape most exposed to the light ripens first. Marié-Davy mentions that in 1875 the vines received more heat from June to September, although it was a poor vintage year, than in the two preceding years; but it was the contrary as regards light.

	Solar heat.	Actinometric degrees.
June, July, and August 1875, . .	2220	4995
" " 1874, . .	2169	5413
" " 1873, . .	2146	5466

This shows that a high summer temperature, without the necessary degree of light, will not cause a good vintage.[1]

Vines will grow on almost any soil, few plants being less particular in this respect; heavy retentive clays, thin beds of soil resting upon strata of rock, and marshy land, being the only exceptions—upon these it is useless to attempt the cultivation. Vineyards celebrated for their produce might be named in which the soil is sandy, calcareous, loam, granitic, light clay, or volcanic; but the presence of flint is often taken as a sign of land particularly favourable for the growing of vines.

Some of the best vineyards in the neighbourhood of Bordeaux afford proof of the high quality of wine which can be produced on soils in which flint is plentiful. The subsoil of the vineyard should be of an open nature, which will permit moisture to escape, and not allow it to collect about the roots; otherwise it would soon cause them to rot. If moisture is retained too abundantly in the soil, it will produce much the same effect as if the moisture were retained in the atmosphere, causing the grapes to produce sour wine, deficient in saccharine matter.

Raisins are grapes dried in the sun, and preserved by the sugar they contain. This was one of the staple industries of the south of Spain before the Phylloxera attacked the vines, the drying of raisins being chiefly conducted at Malaga and Valencia. Muscatel grapes are principally dried at Malaga, the vines being planted in rows rather far apart to admit plenty of sunshine. The production of raisins is conducted in several ways. 1. Most of the leaves are pulled off the vine to allow the full force of the sun's heat to strike upon the grapes. The stem of each bunch is half cut through, or violently twisted, so as to arrest the flow of sap. The raisins are simply allowed to dry on the vines, as the grape does not fall when over-ripe, like most other fruits. The raisins prepared

[1] Article "Actinometry"—Report of Chief Signal Officer for the U.S., 1881.

in this way are considered very superior. 2. When the fruit is ripe, the stem of the bunch is twisted or half cut, as before, and the leaves are mostly removed: this is done to allow the moisture in the grapes to evaporate. The fruit is then cut, and spread on wicker trays in the sun for a day. A lye composed of the ashes of vine-shoots and water, to which some lavender or rosemary has been added, is prepared. Next day this is boiled, and the grapes are dipped three times in the mixture, till they are slightly wrinkled. Care is taken that the lye is not too strong, or the grapes would be too much shrivelled. Sometimes the lye is allowed to cool, and then re-boiled, when the grapes are again dipped three times. The dipped grapes are spread on the wicker trays, and exposed in the sun for three or four days, when they are layered in boxes and tightly packed. The lye is sometimes prepared from wood-ashes and barilla, to every four gallons of which is added a pint of oil and a handful of salt. Sultana raisins are prepared from a seedless grape grown near Smyrna. They come into bearing in the fifth year, and remain productive for sixty years or more. They are planted from six to seven feet apart.

Muscatel layers sell from 40s. to 150s. a cwt.; Valencia, 25s. to 49s.; Smyrna, 23s. to 45s.; sultana, 30s. to 56s. a cwt. Large quantities of raisins are prepared in California, and the industry is being tried in South Australia and the Cape.

Currants are principally grown in the Ionian Islands, and are the produce of the Corinthian grape, a seedless variety which belongs to Greece. The vines are grown on calcareous marl soil in the lowlands or near the sea-coast. The vines are planted from three to four feet apart—propagation being effected by layers, or by grafting the currant-vine on the grape-vine. The stock is grafted a foot or eighteen inches underground; two or three perpendicular incisions are made in the stalk, near the bark, with a chisel, into which the previous year's shoots of the currant-vine are inserted so as to leave two

or three eyes above ground. The grafted part is coated with moist marl. This operation is performed in spring. Grafted plants bear in three years, slips and layers in six.

In December all dead and sickly wood is removed from the vines. In February the vines are repruned, the branches are cut back and the median shoots removed, as they are said to prevent the lateral ones, from the same bud, from bearing, the lateral shoots only being left. In February the land is hoed, and a hollow made around each vine for the reception of water, which is plentifully supplied. In May, when the leaves begin to appear, the ground is stirred and richly manured. In June the new shoots are checked by being broken back. The fruit ripens about the end of July—August being the principal vintage month. The grapes are gathered when they are nearly black and rather over-ripe. They are spread in thin layers upon sheets stretched over earthen barbecues or drying-grounds, and exposed to the full heat of the sun. When thoroughly dry the currants detach themselves from the stalks: this is sometimes hastened by beating them gently with switches, and the turning they receive while drying. The stalks are separated from the currants by a sieve—dust and other impurities being removed by a fan. During the drying of the grapes rain is greatly dreaded. The fruit is packed in casks; the market price ranging from 20s. to 43s.

Current Trade of the United Kingdom.

	1883.	1884.	1885.
	Tons.	Tons.	Tons.
Imported, . . .	51,025	60,378	55,011
Exported, . . .	6,589	8,697	9,063
Home consumption, .	48,576	48,269	45,308

RAISIN TRADE OF THE UNITED KINGDOM.

	1883.	1884.	1885.
	Ton.	Tons.	Tons.
Imported, ...	29,290	25,531	29,193
Exported, ...	4,078	5,343	5,497
Home consumption, .	22,721	22,154	21,150

So much has been written about the cultivation of the vine that it is unnecessary to enter into the subject here, as there are many books which treat of it at great length.

STATISTICS OF VARIOUS WINE-PRODUCING COUNTRIES.

	Production in Gallons.			Acreage under Vines.	Export for 1884.
	1882.	1883.	1884.	1884.	Gallons.
Germany, . .	35,130,788	61,808,582	65,426,152	296,336	..
France, . .	854,157,150	980,670,746	783,098,734	5,422,668	124,529,320
Italy, . . .	583,007,634	614,557,130	..	4,759,275[1]	51,985,258
Austria, . . .	74,082,800	76,430,310	..	613,365	} 450,747
Hungary, . .	90,487,276	101,994,970	97,050,602	930,716	} Met. ctr.
New South Wales,	543,596	589,604	441,612	4,584	..
Victoria, . .	516,763	723,560	763,823	9,095	..
South Australia, .	347,340	358,606	473,535	4,590	..
Western Australia,	..	..	81,753	687	..
Queensland, . .	88,476	119,295	95,358	1,286	..
Cape of Good Hope,	..	..	..	..	89,981
Portugal, . .	..	..	..	..	18,045,192
Spain, . . .	..	..	..	..	142,843,251
California, . .	8,800,000	6,600,000	14,080,000	..	..

The vintage of France is a matter of great importance to the country, an average year producing 53,556,146 hectolitres. In 1883 the average produce per hectare of vines, for the whole of France, was 21.01 hectolitres; in 1884 it was 15.84 hectolitres. In 1865, 30.06 hectolitres were produced to the hectare.

Greece has 800,000 strèmes of vines, which produce wine to the value of £1,785,000. Cyprus, Crete, Algiers, Madeira, &c., are all more or less celebrated for their wines.

[1] In 1883.

Italy shows a marked increase in late years in the production of wine, which is found to be more profitable than ordinary agriculture. The old process of wine-making is now replaced by modern improvements. In 1884, 2,362,000 hectolitres ordinary, and 1,934,000 bottles superior, wine were exported—France taking 1,883,000 hectolitres of wine in cask, and 733,600 bottles; Switzerland, Germany, Greece, Malta, and Great Britain taking the balance of the wine in casks, while the remainder of the bottled wine was exported to different parts of North and South America.[1]

Currants are principally produced in Greece, where there are 350,000 strèmes of Corinth vines, the yield of which was about—

1882, ...	291,457,000 lb.
1883, ...	280,636,000 "
1884, ...	264,527,000 "

the average value being about £2,142,000.

The exports of raisins from Spain show a falling off in the last three years; they were :—

1882, . .	41,779,000 kilogrammes,	valued at	£1,086,000.
1883, . .	35,897,000 "	"	861,520.
1884, . .	26,858,000 "	"	651,080.

Cyprus exported wine to the value of £52,569 in 1881, and to the value of £38,827 in 1882.

The imports and exports of the products of the vine into the United Kingdom were :—

Imports.	Wine.		Raisins.		Currants.	
	Gallons.	Value.	Cwt.	Value.	Cwt.	Value.
1882, . .	15,715,813	£5,458,923	548,911	£1,027,820	1,012,102	£1,351,939
1883, . .	15,559,795	5,451,953	588,309	1,057,934	1,026,584	1,423,062
1884, . .	15,106,271	5,341,117	511,870	874,367	1,202,844	1,603,786
Exports.						
1882, . .	1,398,484	615,440	112,016	199,948	130,975	160,588
1883, . .	1,365,593	581,882	84,598	137,752	135,451	166,727
1884, . .	1,213,671	520,231	108,568	164,072	176,864	199,437

[1] Report by Mr J. G. Kennedy, 1885.

The quantities of the above articles consumed in the United Kingdom are thus calculated by the Board of Trade :—

	Gals. Wine.	Cwt. Raisins.	Cwt. Currants.
1882, . . .	14,339,070	413,403	947,903
1883, . . .	14,287,317	452,453	969,403
1884, . . .	13,994,497	441,668	964,825

The consumption of the wine and raisins and currants per head of the total population of the United Kingdom was :—

	1882.	1883.	1884.
Wine, ...	0.41	0.40	0.39 gals.
Raisins and currants, . .	4.32	4.47	4.38 lb.

ALIMENTARY PLANTS.

ARROWROOT AND STARCH.

MANY plants belonging to the Order Marantaceæ are adapted for cultivation on account of the starch contained in their roots. Among these we find several capable of cultivation in the subtropical and warmer-temperate zones which yield arrowroot. Among these are :—

Maranta nobilis, grows in New South Wales and at Auckland.

Maranta arundinacea, cultivated in Queensland. Indian arrowroot.

Canna edulis, grown in Victoria and New Zealand, about Auckland.

There are numerous sources of arrowroot besides these plants, viz. :—

Dion edule, a native of Mexico.

Tacca pinnatifida, South Sea Islands.

Arum maculatum, Wake-robin, from which Portland arrowroot was made.

Solanum tuberosum, the potato (fig. 9).

Fig. 9.—Granules of Potato-starch.

Zea mays, maize.

Curcuma angustifoli, &c., India.

Canna coccinea or *Tous-les-mois*, St Kitt's, West Indies, &c.

Arrowroot (fig. 10) is only another name for very fine starch, free from taste, and suitable for food. It is obtained

from the roots of the above and other plants, by bruising them and washing out the fecula.

The cultivation is carried on thus: The land is broken up by ploughing, and laid off in rows about two feet apart. Along these are dug holes one foot in diameter and depth. Shoots are taken from the stools of old plants and placed upright in the holes, which are then filled. The season for planting in Natal is spring, during the months of October and November. The land is kept clean by hoeing. When the leaves fade, the roots are dug, generally about a year after planting.

Fig. 10.—Granules of Plantain-starch.

The roots are first thoroughly washed to free them from earth, and are then grated or pounded into a pulp. The pulp is repeatedly washed to free it from all fibrous matter, which is skimmed off the surface. The residue, a milky fluid, is strained through a sieve and returned to a clean vat, where the starch subsides to the bottom and the water is run off. The starch is dried on calico trays, broken into pieces or into powder, and packed in cases as quickly as possible, as it readily absorbs moisture.

In Bermuda the land is deeply ploughed, harrowed, and laid out in drills six inches deep and three feet apart. The pieces of root are put eight inches asunder in the drills. The plants mature in a year, when the roots are collected and carefully washed. The outer skin is removed, owing to a resinous matter contained in it which spoils the flavour and colour. The roots are again washed, and crushed to a pulp between powerful rollers. The pulp is put in perforated copper cylinders and agitated with water by revolving wooden paddles. The water carries the fecula to reservoirs, where it settles and the supernatant liquid is drawn off. Here it is repeatedly washed, and all floating impurities skimmed off. It is dried in the sun in flat copper pans covered with gauze.

Starch is prepared from maize by cleaning the seed and

soaking it for a day; it is then crushed in a roller-mill, and washed till it is freed from all impurities and the water resembles milk. This milky water is allowed to stand, when the starch sinks to the bottom; or it is poured on sloping tables, where the starch is deposited and the refuse water runs off. The nitrogenous matter washed from the starch is excellent food for cattle. Potato-starch (fig. 11) is prepared in a similar manner. If the potatoes are decayed, the starch is bleached by the addition of sulphuric acid, neutralised afterwards by lime-milk or some other alkali. Bleaching is also performed by using chlorine. The proportion of starch yielded by different plants will be seen in the following table, quoted by Seller and Stephens[1] from Pereira :—

Fig. 11.—Two cells of a Potato-tuber, containing starch-grains.

		Starch.
Thallus,	Iceland moss, ...	44.6
Roots, . .	*Janipha manihot* (var. red), . . .	13.5
	do. (var. green), . . .	11.5
	Ipomœa batatas, sweet potato, . . .	7.5
	do. (var. red), . . .	13.3
Tubers, .	Potato, kidney, ...	9.1
	do. red, ...	15.0
	do. shaw, ...	18.8
	do. Champion, ...	15.9
	do. Chair rouge, ...	12.2
	do. Orpheline, ...	24.4
	do. Captain Hart, ...	15.0
Rhizomes,	Arrowroot, ...	12.5
	do.	26.0
	Canna coccinea, ...	12.5
	Canna Indica, ...	3.3
	Ginger, ...	13.0
	do.	19.75
	Turmeric, ...	26.0
	Yam (*Discorea sativa*), ...	12.5
	do.	22.66

[1] Physiology at the Farm.

		Starch.
Seeds or fruits,	Barley-meal,	67.18
	Oatmeal,	59.0
	Whéat-flour,	56.5 to 72.0
	Wheat-bread,	53.5
	Rye-meal,	61.07
	Maize,	80.92
	Rice (Piedmont),	82.8
	do. (Carolina),	85.07
	Peas,	32.48
	Garden-bean (*Vicia faba*),	34.17
	Kidney-bean (*Phaseolus vulgaris*),	35.94

Arrowroot is a well-known and most nutritious article of food, admirably adapted for infants and invalids. In urinary and bowel complaints it is demulcent. It obtained its name from its supposed efficacy in extracting the poison of wounds caused by the arrows of the Indians.

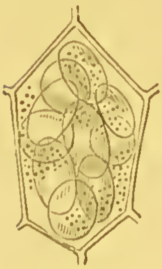


Fig. 12.—Single cell of Wheat.

Granules of Starch.

Starch is the farinaceous part of grain or roots (fig. 12). It is insoluble in cold water, but if water of 140° F. temperature is added to it, it absorbs the water and swells greatly, and the grains become transparent and mucilaginous. When subjected to a dry heat of 401° for one or two hours, it becomes dextrine or British gum, used as a mucilage and in printing calicoes, paper-making, ink, brewing, &c. It is used also for gumming stamps and envelopes, and in making sticking-plaster.

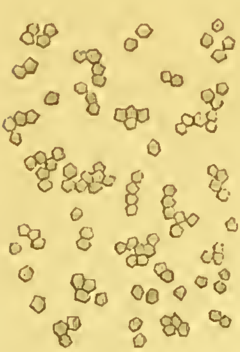


Fig. 13.—Granules of Rice-starch.

Starch is one of the most important nutritive substances in both animal and plant life (fig. 13). Liebig considered it to be only a respiratory food for animals; other chemists believe it to be one of the chief sources of fat. In plants it is formed in the chlorophyll, and there are few plants in which it has not been

found. It is stored in the cells of the plants till wanted, when it is dissolved and used as a formative material in the creation of fresh cells. Starch, as we have seen, is insoluble, and to enable the sap to convey it to the other parts of the plants, it is, by fermentation, converted into a soluble sugar (glucose), and borne by the sap to those parts of the plant which are growing. The starch found in seeds is not formed within the seeds, but in the leaves, from which it is carried as glucose to the seeds, where it is again changed into its original form. When the seed begins to sprout, water is absorbed, which, acting upon the starch by fermentation, converts it once more into glucose or sugar; hence the sweetness of malt or sprouted barley. In the case of bulbs or tubers, the process is the same. The starch is not formed in the tubers, but in the leaves, from which it is conveyed to the former.

BANDAKAI, OKRO or GUMBO (*Hibiscus esculentus*).

This most delicious vegetable, known as Bandakai in South India, and Okro in the West Indies, is well worth the attention of residents in Australia and other subtropical and warm-temperate colonies, especially as it comes to maturity in Victoria.

It contains a large quantity of albumen, and is used in the East and West Indies for thickening soup. It is very nourishing, and an excellent vegetable when boiled and served with a sprinkling of pepper. The leaves are demulcent and emollient, and, with the young fruit, are used for poultices in the tropics. It yields a long, strong, and silky fibre, suitable for ropes, string, sacks, &c., and used in France for making paper of good quality. A decoction of the fruit is said to be a remedy for catarrh. The seeds give a rich table-oil. It grows to a height of from three to five feet. The seeds may be sown in a box or frame, and the young plants afterwards pricked out into beds of good rich earth, about two feet apart. The capsules are eaten green.

THE CAROB (*Ceratonia siliqua*).

Nat. Ord. LEGUMINOSÆ.

A small branching diœcious tree, from twenty to thirty feet high, with dark-green pinnate evergreen leaves, flowers in red racemes. The fruits are flat brown pods, generally curved, from six inches to one foot in length, containing a number of small hard seeds, each enclosed in a separate cell. These pods are commonly known as locust-beans or St John's bread, and the tree is often known by its Spanish name Algaroba. The pods are full of a sweet mucilaginous matter, containing sixty-six per cent sugar and gum, and are consequently very fattening food for cattle. The tree bears heavily in Cyprus, Asia Minor, and the Grecian Islands, half a ton of pods being borne by a large tree. It is a native of the countries bounding the Mediterranean, and requires a similar climate to the orange, but if anything rather more heat. It grows at Valencia, in Spain, to an elevation of 500 feet, and in South Grenada to 2000 feet. It can be grown in warm localities about Nice, in France. In Italy it grows on the hills around Naples. In Corsica and Algeria it grows well, and it is a common tree in Sicily. It is a tree requiring warm summers and warm winters, where the mean yearly temperature is not less than 64°; but it succeeds best where the temperature is 66°, and the climate dry and hot. In Italy it grows best on the hills overlooking the sea. It will not grow in wet or marshy land, doing best in sterile, stony places, with a calcareous subsoil.

The carob is generally grown from seed planted in nurseries, or at stake, in well-manured earth. The seeds are soaked in water for three or four days, the water being changed every day. When they begin to swell they are planted, and lightly covered with earth. If they are planted in nurseries, put the seeds eight inches apart. In three years they are shield-grafted with a dormant bud at the end of summer. If the tree is a male, each branch must be budded from a female tree, reserv-

ing one ungrafted male branch to ensure fertilisation in after-years. If the tree is female, one branch must be grafted with a male bud for the same purpose. The head of the tree is formed of four primary branches, and the only pruning needed is to remove gourmand branches and those that grow out of order or across the tree. Care must be taken in watching the male branch to ensure it being male, as on this depends the future fertility of the tree.

In the case of nursery plants, they may be transplanted the year after grafting, an operation requiring great care, and necessitating watering during the following summer, or even irrigation if the climate is very dry. In France the trees are planted 50 feet apart. The tree begins to bear about two years after transplanting, or at about eight years old. It flowers in autumn, and the crop is picked the following autumn, when the pods begin to fall of their own accord. The pods are knocked off with poles, spread in dry sheds where there is plenty of ventilation till quite dry, and never heaped together till they have lost all their moisture, or they would ferment. About 2 cwt. of pods constitutes the crop of an average tree near Nice; but at Valencia a tree is said to have borne 27 cwt. of pods—a most astonishing return from one tree.[1]

The composition of the carob is—water, 11.6; albumen, 7.1; sugar, 51.8; pectose and gum, 16.1; fat, 1.1; mineral matter, 2.9; lignose, 6.4. In 1881 Cyprus exported 47,037 cantars carobs, to the value of £44,076; in 1882 the export was 87,194 cantars, valued at £65,446.

CHESTNUT (*Castanea vesca*).

Nat. Ord. Corylaceæ.

The chestnut was probably originally a native of Asia Minor, but has long been spread all over the warm-temperate

[1] Du Breuil.

zone. These trees grow best on a sandy loam, but will grow on any good soil provided it is deep and well drained, especially if it is on a granite formation.

The finest nuts are selected and sown in beds in spring, the pointed side of the nut being placed downmost. In two years the plants are put in fresh beds, at distances of two and a half feet apart. Here they are trained into shape till they attain a height of about seven feet, when they are planted out at distances of from forty to fifty feet apart. When they are well established they are cut back to a height of about nine feet, after which they throw out branches. Five or six of the best of these are chosen, situated at the top of the tree, on which the grafts are placed. These may be grafted with the English cleft graft, flute-grafted, or budded with a dormant bud, according to the fancy of the operator. The after-cultivation of the tree is simple, and consists merely in removing dead wood and suckers, and in preventing bushes, &c., from growing too near the tree. By turning the soil round the tree from time to time, and applying manure, the growth of the tree may be hastened.

The chestnut ripens in Scotland in warm situations. In the United States it grows as far north as lat. 44°. It is well suited for cultivation in New Zealand, Tasmania, and parts of temperate Australia. In New Zealand it would be well to introduce the species which grows in Madeira, which would probably succeed in the province of Auckland. There are numerous varieties of this tree. French cultivators recognise about thirty kinds. Any failure in growing chestnuts in Australasia probably arises from not selecting a variety suited to the climatic conditions of the part where the cultivation has been attempted.

The uses of chestnuts for food are well known. In parts of the south of Europe they form an important article of food for the people. They are eaten boiled, roasted, or reduced to flour and made into bread. They may be used to thicken soup, as stuffing for geese and poultry, or

beaten up with cream. They are also used to fatten domestic animals.

The chestnut commences to fruit about five years after grafting, but does not come into full bearing till fifty or sixty years old. The nuts should be gathered shortly before they are fully ripe; the outer covering is removed, and the nuts spread on a dry surface in barns, where they are sheltered and at the same time exposed to currents of air: they are turned from time to time till fully dry. Artificial heat is sometimes employed to dry them quickly, fires being lighted of materials which give little flame but plenty of smoke. When the husk of the nut is hard, the nuts are considered to be fully dry. The yield of a large tree is from 1 to 1¼ cwt.

It is strange that more attention has not been paid in New Zealand to cultivate a tree which is of so much importance, and which would probably adapt itself to the country if a little time and trouble were devoted to raising different kinds.

The timber is good, and used by cabinetmakers and coopers. It is very durable, and makes excellent posts, which last longer than oak. It has a close grain, and takes a fine polish.

Italy had, in 1883, 1,108,319 acres chestnuts, which bore 6,675,987 cwt. France, in 1882, had 477,734 hectares, the average yield of chestnuts being 14.43 hectolitres the hectare; the total crop was 6,891,357 hectolitres, averaging in price 8 francs 94 centimes per hectolitre; total value, 61,595,738 francs.

CHICK-PEA, GRAM, EGYPTIAN PEA, CARAVANCES
(*Cicer arietinum*).

Nat. Ord. LEGUMINOSÆ.

A leguminous plant much cultivated in India and the Mediterranean regions. An annual, about one foot high;

flowers rose-coloured or white. The pods are produced singly on stalks growing from the base of the leaves. They contain one or two wrinkled seeds under a quarter of an inch in diameter, used by the natives of India as food, either in curry or ground into coarse meal. They are excellent food for horses, and the herbage is good fodder. The peas contain a great deal of nourishment, and are said to be the parched pulse used by the Hebrews in travelling: they are still largely used in the East for desert journeys, forming a portable and highly nourishing food. In France they are used to thicken soup. The leaves and stems exude oxalic acid in hot weather, to an extent said to injure the boots of any one walking through the fields in the early morning.

The seeds may be sown in drills, like peas, two feet apart. The plant grows upright. The pods are gathered as soon as they are ripe, the plant being either cut or rooted up by hand. In India the value of a crop of gram, grown as a second crop, was £15—the cost of cultivation being £3, 10s.[1]

The great nourishing power possessed by gram is due to the large amount of gluten contained in the pea. The pea, when roasted and ground, is not a bad substitute for coffee,[2] as it contains an aromatic principle which somewhat resembles that of the "fragrant berry."

CHUFA, OR EARTH-ALMOND (*Cyperus esculentus*).

Nat. Ord. CYPERACEÆ.

This perennial sedge-plant, a native of Southern Europe, is known in France as *Souchet comestible* or *Almande de terre*. It is a rush which grows to a height of three feet, and forms tubers about the size of a bean or nut.

The tubers are planted in spring, in rows two feet apart,

[1] Greenaway, Farming in India. [2] Johnston.

with the same distance between the tubers. These may be planted in hills, with several tubers to a hill, when "the produce of one bushel to the acre has been 200 to 500 bushels."[1] The bulbs are difficult to harvest: they can be dug up with forks in autumn, and preserved like potatoes.

These tubers may be eaten raw or cooked, their taste resembling chestnut. They have been suggested as a substitute for coffee. Their chief use is to form a refreshing beverage, much used in Spain, and known as *orgeat de chufas*.[2] The tubers are soaked in water for two days, then pounded, mixed with sugar and water, and strained when the decoction resembles milk. It is sometimes frozen.

COFFEE (*Coffea arabica*).

Nat. Ord. RUBIACEÆ.

A native of the Abyssinian mountains, first introduced into Arabia, and about 200 years ago brought by the Dutch to Java, from whence it was taken to the Botanical Gardens at Amsterdam, and thence to the West Indies about 1715. The coffee plant is therefore a native of the tropical mountains. We, however, find it growing in extratropical countries where it is not exposed to frost. Experiments made in the United States show that the temperature must never fall below 50° F., or the plant suffers. In the higher districts of Ceylon, hoar-frost occasionally does much damage, the frosted trees being scorched and withered as soon as the sun strikes upon them. In the southern hemisphere coffee is cultivated at Natal (lat. 30° S.); in the northern hemisphere it is grown at Madeira to a limited extent (lat. 32° 23′ N.); in the Sydney Botanical Gardens the plant fruits, but could not be profitably cultivated.

[1] Encyclopædia Americana.

[2] Pharmaceutical Journal, 1876.

On the hills of the western side of Ceylon, the best estates were situated at an elevation of from 2000 to 4000 feet, but the cultivation was remunerative at 5000 feet; on the eastern side of the island, where the climate was drier, coffee could be cultivated to an elevation of 500 feet more. On the Blue Mountains of Jamaica the trees bear well at 4500 feet elevation, which is also the case in Guatemala. In Mexico, 4000 feet is about the limit of profitable plantations.

C. arabica is a rather straggling tree with alternate branches, attaining a height of eighteen or twenty feet, with handsome dark-green leaves and a highly scented white flower resembling jessamine, which is succeeded by clusters of from ten to twenty berries round the twigs; these are first green, then red, and reddish-purple when over-ripe. In order to facilitate gathering the berries, and for purposes of cultivation, the trees in Ceylon are usually cut down to a height of about three feet, when the plantations resemble fields of laurel, and, when the blossom is out, have a lovely appearance. In Central America the trees are topped at six feet.

The best soil for coffee is a rich chocolate mould, a limestone formation being especially favourable; plenty of vegetable humus is necessary, and the soil should be rich in potash. Coffee should always be planted on forest-land. The presence of boulders of rock has a beneficial effect. These rocks not only afford natural drainage and keep the soil together, but from the combined influence of atmosphere and rainfall, aided by the roots of the trees, they are continually disintegrating and forming fresh soil, thus manuring the land naturally. Boulders also absorb the solar heat during the day, radiating it at night and increasing the temperature, thus favouring the growth of the plant. The same advantages are found when estates are situated at the base of a precipice, where the soil is sure to be rich and the land sheltered on one side.

The coffee-tree requires an equable climate, with a mean annual temperature of from 76° to 66°, and a rainfall of from 80 to 90 inches. When the rainfall is excessive the blossom suffers,

the trees run too much to wood, and are attacked by black-bug, fungi at the roots, &c. Where the rainfall is insufficient, the bean is light and does not fill out properly, the trees fail to mature the crop, the branches die back, and if the crop is heavy the trees are severely shaken and do not recover easily.

The most important consideration in opening coffee-land is to obtain perfect shelter from strong winds. It is useless attempting to grow coffee on exposed land. Sheltering belts of forest should be left wherever they seem necessary, as has been recommended in the article upon tea. These belts of jungle also protect the estate from vegetable diseases and the ravages of insects, which often do great damage to plantations. My advice to those about to open new land, is to go over it to examine its natural features, and plan out the estate before a field is surveyed or a tree felled. The course of the prevailing winds must be considered, and the slope of the forest-trees will give some indication as to this.

The best situation for an estate is a gentle slope which faces the morning sun. Aspect is a matter of great importance, especially to estates situated at a high elevation, which require all the solar heat possible, and should therefore in the northern hemisphere always face east or south-east. It will be found that such estates grow faster and give earlier and more uniform returns than those having an opposite exposure. At low elevations, where the heat is great and the estates may receive rather too much sun, a westerly aspect is often preferred.

In Ceylon the forest is felled and cleared by contractors for £2 an acre. The undergrowth is first cut with heavy socket-knives on handles; axemen follow, who cut the trees one-third through on the lower side; they next cut them to a similar depth rather farther up the stem on the upper side, passing on to the next tree, and leaving the partly cut trees standing. When they come to some giant tree farther up the hill, they fell it, and in falling it brings down the partly cut trees below it; and one may thus see several acres of trees go crashing

down together. The branches of the fallen trees are lopped off, and in from three to six weeks' time, according to the weather, the clearing is fired on a fine day at the lower side, when the branches and undergrowth should be completely consumed, leaving only the charred stumps and trunks of the large trees. A slow burn is better than a fierce one, which consumes too much of the vegetable humus of the soil. Any unburnt parts are piled, and burnt afterwards by the contractor.

A piece of level land, near water, is chosen for a nursery, trenched to a depth of eighteen inches till thoroughly friable, and laid out in slightly rounded beds four and a half feet wide, with narrow paths between them. The finest parchment coffee is selected as seed. It can be sprouted before sowing by mixing it with earth, watering the heap, and allowing it to stand for two days. The seeds are planted one inch deep and three inches apart, in rows across the beds. The beds are watered once or twice a-day, and are sheltered like those for tea. The seedlings are best transplanted just before the first pair of primary branches begin to show. Nothing is gained by putting out larger plants, as the small plants six inches high bear removal much better than larger ones. When larger plants are in the nursery, they are better planted as stumps, the stem being cut through four inches above the collar, and the roots trimmed to a pear-shape. Such stumps are useful for planting in dry weather. Nursery plants are plentifully watered the night before removal, the soil is loosened with a pronged fork, and the plants carefully raised by hand and put in shallow baskets. If possible, keep a ball of earth round the roots. The plants are carefully gone over by a good coolie, who trims the roots when required, and shortens the tap-root if necessary; plants with bent tap-roots are rejected altogether. A month before moving the plants the shade is taken from the beds to harden the seedlings. The seedlings are about six months old when fit to remove.

When the clearing is burnt off, it should be roaded as quickly as possible: the course of these roads depends upon

the situations of the necessary estate buildings. If time permits, drains should be cut at the same time, before the wet season sets in.

The different operations of roading, draining, lining, holing, and planting are sufficiently described under the head of Tea, with the following exceptions: The lining should be done with a differently marked rope to that used for tea clearings. The usual distances of planting are 6 × 6 feet, or 1210 trees to the acre, in hot forcing climates, where the trees grow large; 5½ × 5½ feet, or 1440 trees to the acre, for coffee at a considerable elevation; sometimes the lines are 6 feet apart with 5½ feet between the trees, or 1320 trees to the acre. The coffee-trees should just meet without interfering with each other, in order to prevent the growth of weeds. In Central America, 9 × 6 feet, is a usual distance, and even up to 12 × 12 feet. Holes for coffee should be eighteen inches wide at top and bottom, and the same in depth.

When the clearing is planted, it is supplied later in the year, and also in the next two years, after which it is better to plant cinchona in any vacancies, as late coffee-supplies seldom do any good.

It is an important matter to keep down weeds from the first, and weeding must commence soon after the clearing is burnt. Weeding must be performed monthly, and done entirely by hand, or only with the aid of a sharp-pointed peg. Each weeder must have a bag tied round his waist in which he puts the gathered weeds, which are finally deposited in pits dug for the purpose at convenient situations. The weeders should remove all double stems which may grow from the young plants, as well as all suckers.

When the trees are of sufficient height to top them in the brown wood, this must be done. For ordinary coffee, three feet will be found to be a convenient height. Low-topped coffee has more strength and energy in it than high-topped, and the latter generally loses some of the lower branches; consequently the tree has to draw up its supplies of nourish-

ment from a greater distance. On very rich level land, the trees may be allowed an extra six inches of height; but it is doubtful if it is altogether advisable. For coffee at a very high elevation, two and a half feet is tall enough. It is better, after cutting off the top, to remove one of the upper pair of primary branches, or the tree may split when bearing a heavy crop. After topping, the stems must be kept free from suckers, and all secondary branches must be removed for a distance of six inches round the stem to admit light and air.

If the trees are liable to be shaken by wind, it will be necessary to stake them. This is done by driving a stout stake into the ground on the side opposite from where the wind blows. The stake must slope towards the wind, and cross the stem of the tree at about two-thirds of its height. The tree is fastened to the stake by a band of "jungle rope" or flexible creeper, and tied in the form of the figure 8, the stem being in one circle and the stake in the other.

Coffee usually gives its maiden crop when three years old. When the berries assume a deep-red tint they must be picked, and all the beans taken which one can squeeze out of their pulp with the fingers. Every coolie has a "cooty sack" about eighteen inches long and twelve inches broad tied round his waist, and a three-bushel bag in which he puts the contents of the smaller one when full. Each coolie has a line allotted to him, and they should be encouraged by the prospect of a little extra pay to bring in as much cherry as possible. The picker runs his hands down each twig, stripping off the ripe berries and leaving the green with a dexterity which is wonderful. The attention of master and overseer must be close to prevent crop being left on the trees. The estate must be gone over systematically from end to end, as much crop would be lost were the men to pick the parts which seem ripest. It is usually best to arrange the round so as to take the lower and earlier fields first. In dry weather crop hangs longer on the trees than in wet.

When the day's work is over, the cherry is carried to the

receiving-house and measured in the manager's presence, who marks the quantity brought in by each coolie in the check-list. The cherry is usually measured in a box, rather larger than a bushel-measure, the bottom being hinged to let the cherry escape when done with. It is always better to pulp the cherry as soon as possible, as it becomes discoloured if left too long. When the measuring is fairly started, pulping should begin; and the coffee is run down from the receiving-house to the pulping-house as soon as the machinery is in motion. Here the cherry is floated into the pulper, which separates the pulp from the bean, the former being washed into the pulp-pit, and the beans run into the nearest empty cistern.

While the pulping goes on, it is well to occasionally examine the pulp passing out at the back of the pulper, to see that everything is working properly, and that no beans are being carried out with the pulp. Also notice the beans as they go towards the cistern, and see that the pulper is not damaging them. When the whole of the cherry is pulped, the wet parchment is heaped together in the cistern and covered with a few old sacks to hasten fermentation. If the estate is in a hot district, it remains thus for two days before washing; but if the climate is cool, it requires three days to ferment—the coffee pulped on Monday afternoon being washed on Thursday morning.

The washing-cistern is considerably sloped. At the higher end a plentiful supply of water falls from a slight elevation. The coffee is shovelled into the washing-cistern, and shoved with poles having a cross piece of board fixed to one end, up to the higher part right under the water. It is soon washed down to the lower end of the cistern, when the operation is repeated several times, till the mucilage is all washed off and the beans look clean and bright. It is then thrown on the drying platform to let the water run off, carried to the barbecue, measured roughly, and spread out an inch thick to dry. As one lot of coffee is washed, another is let into the cistern. From time to time the door leading into the tail-cistern is raised to allow the "light coffee," imperfect and abortive

beans, to float into it. At night, before pulping the new cherry, this tail-coffee is brought to the pulper in baskets and repulped. By doing this, any good coffee which may have escaped is saved, and the tails reduced to a minimum. When dried, this tail-coffee is usually pounded out in wooden mortars and sold for what it will fetch.

When the sun begins to decline, the newly washed coffee is collected and put in a heap on the lower floor of the store. If the next morning is fine, it is put out at 6.30 A.M. and again sunned, the storeman keeping a careful eye on the weather, and taking it in on the least threatening of rain. Should the day be wet, it is turned twice with wooden shovels, from one side of the store to the other, to prevent it heating. After three days' sunshine it is dry, when it is sown up in three-bushel bags and despatched to Colombo as "parchment coffee." In this stage, in calculating the weight, four and three-fourth bushels go to the hundredweight.

The curing establishments in Colombo are very large, some of them employing 1000 hands a-day. The coffee, on arrival, is measured. Next day it is spread on asphalt barbecues, where the heat is excessive. This causes the horny parchment skin to crack. It is then put in a trough, in which it is subjected to a heavy revolving wheel with a milled edge, which removes the parchment, and then fanned. Next day the coffee is again exposed to the sun, after which it is passed under a wheel once more, to remove the silver skin, and afterwards fanned. The next process is sizing. The coffee is passed through an inclined perforated cylinder, which revolves slowly, the holes at the upper end being smaller, and gradually increasing in size towards the lower end. The coffee is garbled, all defective beans being picked out by native women. It is usually packed in casks for shipment. The cost of curing and packing in Colombo was from Rs. 1.75 to Rs. 2.25 a hundredweight.

The first rule of pruning is to keep the centres of the trees open for a radius of six inches round the stem, and to keep

the stem free from suckers. This allows light and air to penetrate into the tree. As this must be done constantly, it is better to make the weeders do it, as has been already remarked.

Shortly before the maiden crop ripens, it will be necessary to handle the trees. Each coolie has a row of trees to handle, and his duty is to pull off all double shoots, shoots growing backwards or across the other branches, "riders" or those growing above the primary outwards, and if there is a superfluity of young wood, lessening it, so as to retain only the best shoots, which will then receive more of the sap, and will develop faster. To keep an estate in thorough order, two handlings are necessary a-year; and they will be found to reduce greatly the cost and labour of knife-pruning, and economise the energy of the trees.

As soon as the crop is gathered, knife-pruning must commence. It is better to send a gang of children before the pruners to handle out the trees, removing all useless young shoots, which often choke the trees. This cannot be done too soon, as the trees require all their strength to mature wood for the spring blossom. Knife-pruning is difficult to describe, and a single lesson will teach more than a book on the subject. The following rules should be attended to: 1. Never cut a primary branch. 2. Without removing any of the good bearing-wood, cut off the surplus, so as to let air and light into the tree. 3. Take off all wood which has borne. 4. Remove branches growing backwards towards the stem, and cross wood which interferes with the other branches. 5. Suppress riders growing above the primaries. 6. Cut off "gourmandisers," or branches which spring from the primaries, absorbing all the nourishment into themselves till they look like young trees. 7. Only leave bearing-wood on the trees, removing useless, whippy, soft twigs, which do no good.

The coolies should each have a pruning-knife made specially for the purpose. When a large gang is at work, there should be a man with an oil-stone to sharpen knives, with a spare knife

ready when wanted. One man should have a saw, as it is frequently needed, especially in old coffee.

Manuring is seldom necessary till after the second crop, but all manure made on the estate can be applied in small doses to those parts which have borne the heaviest maiden crop. Young coffee must be manured with caution, for if over-stimulated it will also over-bear, and suffer in consequence. If once heavy manuring is begun on an estate, it must be continued. For the first few years the planter, knowing that his trees are exhausting certain ingredients of the soil, should content himself with restoring these, and maintaining the fertility of the estate till his trees are thoroughly established, when he can begin high cultivation. Never allow coffee to get into low condition: it is easy to keep it up to the mark, but a hard matter to resuscitate a neglected estate. When coffee begins to fail it responds immediately to manure; but neglected coffee requires very careful and judicious treatment, and a very heavy dose of manure may finish it altogether.

The usual manures for coffee comprise: cattle-dung, ashes, compost-heaps, pulp, sweepings from the coolie lines, bones, lime, oilcakes, fish-manure, superphosphate, nitrate of potash, and other chemical manures. Of these, nothing is, to my mind, so good a general manure as cattle-dung, especially if it has been worked up well by pigs. Pulp is useful in compost-heaps, or for mixing with other manures, but is of itself of little value. Ashes are valuable, and may be dug in alone or mixed in compost. These compost-heaps are easily made, and wherever there is decaying vegetable or animal matter one should be formed, adding lime or nitrate of potash now and then. Even layers of succulent vegetable matter, earth, and lime is valuable when decomposed. The sweepings from the coolie lines contain a good deal of potash and ammonia. A good plan is to have an enclosure, about twenty feet square, in which all refuse is put, and where the line pigs can be kept: if cut out of a slope of earth, such a pit costs little, and soon repays itself with manure. The lower sides can be of outside

boards. Bones are most valuable for increasing the yielding power of the trees. Steamed bones act rather quicker than crushed. From a quarter to one pound of bones is the allowance for a tree. They are best applied mixed with oilcake. One ton bones to three or four tons castor-poonac was a favourite coffee-manure in Ceylon: of this from three-quarters to one pound was usually applied to a tree. Lime is a useful manure, especially where the soil is soured. From one to one and a half pound should be given per tree. Oilcakes or "poonacs" are useful for giving foliage; they are generally mixed with bones,—from a half to three-quarters of a pound poonac was a light application. Chemical manures, such as nitrate of potash, kainit, nitrate of soda, &c., are valuable, and probably are the better of being mixed with pulp or compost at application. Bulky manures are buried in holes, which may be two feet long, one foot and a half broad, and one foot deep, and cut between every four trees, or half-way between every two trees in the line. Another way is to cut semicircular holes two and a half feet long and eight inches broad and deep above each tree. Bones, lime, and similar manures, may be applied thus: take a jam-tin or two which hold exactly the allowance of manure for one tree; send two boys ahead of the gang to sprinkle one tin of manure on the ground two feet above each tree, so as to allow as many roots as possible to reach it. The men follow with four-pronged forks, which they drive into the ground, and work backwards and forwards till the manure sinks out of sight; but do not let them force up the earth, or they will injure the roots.

The diseases of coffee mostly arise from fungoid growths. The most fatal is the "leaf disease" of Ceylon, *Hemileia vestatrix*, which attacks the under side of the leaves, denuding the trees of their foliage: no remedy has been found for it as yet. Certain fungi also attack the roots, but, so far as I am aware, these have been generally overlooked. The insect-pests comprise black-bug, and mealy or white bug; two species of Coccus, the former attacking the leaves and twigs, and the latter the roots;

borer, *Xylotrecus quadrupes*, which tunnels into the stems. The larvæ of cockchafers and rosechafers have done much damage in Ceylon. The best account of insects inimical to coffee is Neitner's 'Enemies of the Coffee Tree,'—Colombo: A. M. & J. Fergusson.

There are numerous forms of "pulpers," the machines which separate the parchment coffee from the pulp. The best is the "gearless" made by Messrs Walker & Co. of Colombo, or their London firm, Messrs Walker Bros., 88 Bishopsgate Street. It will work to over 120 bushels cherry an hour. For small estates the same firm make disc pulpers to work by hand or power. There are many forms of pulpers in use, working by hand, steam, or water-power.

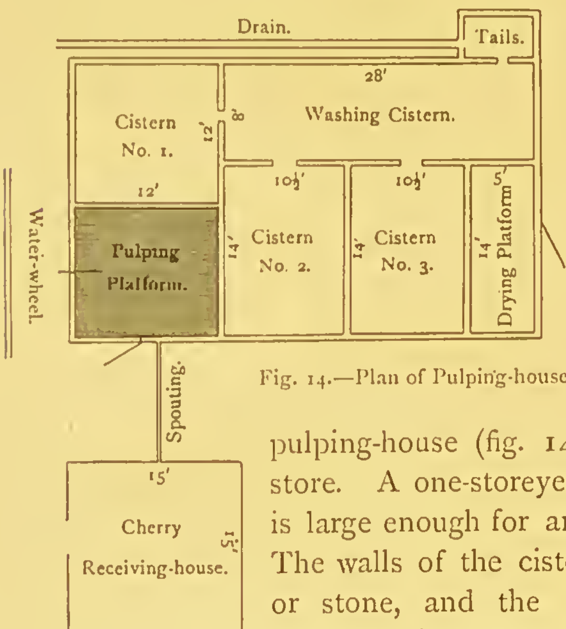


Fig. 14.—Plan of Pulping-house.

Buildings.—It is better to have the pulping-house (fig. 14) detached from the store. A one-storeyed house 43 × 25 feet is large enough for an estate of 200 acres. The walls of the cisterns may be of brick or stone, and the floors metalled and covered with cement or asphalt, or, preferably to either, concrete. The cisterns must have a slight slope on the floors, to allow water to drain off. The washing cistern should have a slope of eight inches. Where it is necessary to practise economy, and good timber is procurable, the cisterns can be made of two-inch planks of hard wood; but the planks will have to run lengthways in the cisterns, and be carefully put together. The pulping platform must be of solid masonry, with sunk six-inch drains running to the smaller cisterns. The drying platform is used for

throwing the wet coffee on after it has been washed. The floor is sparred with 2 × 1 inch spars, and covered with wire-netting. The sides of the house should be sparred with similar spars. There are two doors leading to the drying and pulping

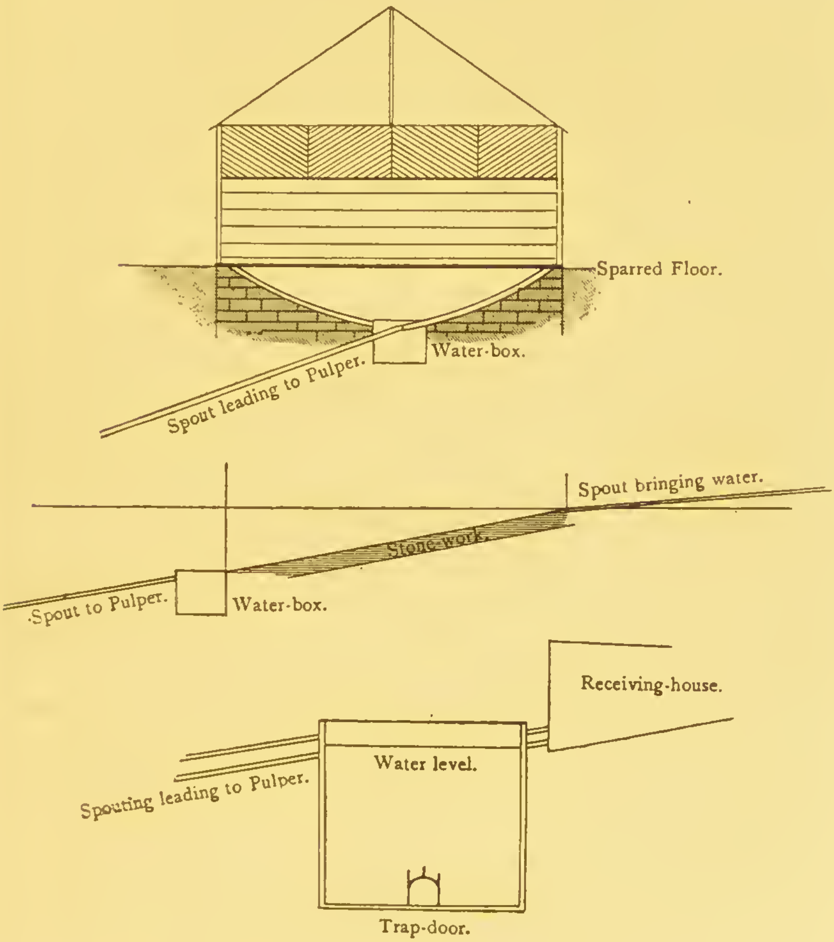


Fig. 15.—Plan of Receiving-house.

platforms. The tail-cistern is better outside, and may be left uncovered. The best roof is galvanised iron; but Willesden paper might be used, and would save carriage.

The receiving-house (fig. 15) should be on higher ground than the pulping-house; about twelve feet will do. It is

simply a wooden box fifteen feet square, with the upper part of the sides sparred. It is better to have it self-acting. The floor is sparred with reefers 2 × 1 inch, resting on joists, the spars being three inches apart. The bottom is of stonework, concreted, and slopes towards the pulping-house. The cherry, after measuring, passes between the spars on to the sloping concrete under-floor; and the water, which flows in at the higher end, carries it into a water-box three feet cube, into which any stones which would damage the pulper, sink; and the spouting fixed at the top of the box receives the floating cherry and conveys it to the pulper. The water-box is of two-inch plank, and should have a sliding door at one side to clean it occasionally.

The store for an estate of 200 acres, should be a two-storeyed building fifty feet long by twenty-five feet broad. The ground-floor should be two feet above the earth, to ensure dryness and allow free circulation of air. It should rest on solid stone pillars two feet square, over which should be eighteen-inch stone or brick pillars eight feet high, to support the upper floor. The beams of both floors must be very strong, and of the best timber—old railway rails are better still. The joists are eighteen inches apart, and the spars over them of the usual size, two inches broad and one thick. Over this fine wire-netting is nailed, and a free circulation of air ensured. The sides are sparred or weather-boarded according to fancy. The coffee in process of drying is kept on the lower floor, and the dry parchment on the upper.

Barbecues are made of beaten earth, and when used are covered with coir matting. At night the matting is rolled up and put in the store.

The pulper should, if possible, be worked by water-power; but if water is scarce, a small steam-engine can be used.

The bungalow and labourers' huts had better be constructed according to the custom of the country. In Ceylon a bachelor's bungalow could be erected for £150.

The tools required comprise—*momoties* or hoes, pickaxes, *catties* or socket-knives, axes, pruning-knives, a road tracer, and prismatic compass for lining.

In Ceylon an estate could be brought into bearing, including buildings, for from £15 to £20 an acre.

The consumption of coffee is decreasing in England. Messrs Rucker & Beucraft, in their price current of 7th January 1886, show the annual consumption of coffee per head for the total population of the United Kingdom to be—in

1860.	1870.	1880.	1883.
1.23	0.98	0.92	0.89 lb.

They further state that the consumption in the United States amounts to 650,000 tons yearly, while that of the United Kingdom is but 13,000 tons. The reason is well known: it is almost impossible to get a good cup of coffee in England. Adulteration is so openly practised that it is not an easy matter always to get pure coffee; and when one does get it, the coffee has probably been roasted long before, and the aroma entirely lost.

To obtain good coffee, every family should roast the bean as they require it, for one, or at most two, days' use. M. Picard, Strand, London, the well-known coffee engineer, has invented a roaster for families which is quite inexpensive, and consists of a sphere of sheet-iron, which opens in the centre to admit the beans. It is fixed on a handle, and is held over the fire, turning it round. In the 'Pharmaceutical Journal' for 1865 there is an able article by Baron Liebig on making coffee. He advises roasting the beans till they lose their horny condition and become pale-brown. The volatile principle of the coffee may be retained by sprinkling over the beans, while roasting, half an ounce of powdered white sugar to each pound of coffee. For every breakfast-cup of coffee roast half an ounce of the raw beans. The Eastern plan of boiling coffee gives an excellent infusion: the ground berries are put in cold

water and allowed to boil for a few seconds; prolonged boiling destroys the aroma. Baron Liebig's method is to boil three-quarters of the coffee to be used, for about ten minutes, then add the remaining quarter and immediately remove the pan from the fire, cover it, and let it stand for six minutes, and strain into the coffee-pot. The strength is obtained from the three parts boiled, the last quarter giving the aroma.

The consumption of coffee in the principal countries of the world in 1884 was about as follows:—

	lb.		lb.
Russia,	18,216,000	Belgium,	44,441,456
Norway,	16,247,000	France,	149.682,456
Sweden,	31,291,000	Switzerland,	20,187,860
Denmark,	16,245,533	Portugal,	5,201,440
Hamburg,	219,298,000	Italy,	35,889,936
German Empire,	244,882,693	Austro-Hungary,	78,051,380
Holland,	83,692,492	United States,	534,786,000
United Kingdom,	33,017,600	Greece,	1,939,472

Besides which there is a large amount consumed in coffee-producing countries.

The supply of coffee is obtained chiefly from the following countries:—

	1883-84.	1884-85.	Average prices 1st January 1886.
Brazil,	5,983,280 cwt.	7,286,000 cwt.	34s. to 39s. 9d.
Java,	1,666,000 "	1,567,000 "	25½ cents in Holland.
India,	360,000 "	320,000 "	...
Ceylon,	324,000 "	310,000 "	62s. to 104s.
Malaysia,	332,380 "	332,683 "	...
Hayti,	...	630,000 bags.[1]	...
Venezuela,	...	440,000 "	...
Guatemala,	425,000 bags.	510,000 "	40s. to 54s., middling.
Porto Rico,	314,000 "	420,000 "	...
Maracaibo,	..	220,000 "	...
Costa Rica,	357,000 "	150,000 "	54s., middling.
Jamaica,	...	60,000 "	...
Nicaragua and Honduras,	80,000 "	80,000 "	56s. to 100s.

[1] Of about one hundredweight and a quarter.

The imports, exports, and consumption of coffee during the last four years has been—

	1882.	1883.	1884.	1885.
Imported, . .	1,364,084	1,407,134	1,137,655	1,035,600 cwt.
Value, . .	£5,201,536	4,936,465	3,750,413	...
Exported, . .	1,016,348	983,712	973,849	737,200 "
Value, . .	£3,971,336	3,431,269	3,255,352	...
Retained for consumption, .	278,701	281,804	287,997	298,400 "

LENTIL (*Ervum lens*).

Nat. Ord. LEGUMINOSÆ.

Was one of the first plants cultivated by man. We read how "Jacob gave Esau bread and pottage of lentils." To this day lentils are a common food of the inhabitants of Syria, Palestine, and Egypt. In India they are greatly cultivated, and generally known as *dhall.* In South and Central Europe, lentils are a common food among the peasantry. In England, lentils husked, ground into flour, and seasoned, are sold as Revalenta or Ervalenta. They are highly nourishing, but should always be decorticated, or freed from the outer skin, before being used, or they will be found indigestible. If this is done they will not only be found most wholesome food, but from their mild laxative property will prove a valuable preventive for indigestion and bilious complaints, promoting the flow of bile and other juices of the digestive organs. As they part with the greater part of their active principles in boiling, they are more efficacious when boiled in soup or beef-tea; but twenty minutes, or at most half an hour, is long

enough to render them soft and palatable.[1] The composition of lentils shows their value as a food :—

Water, ...	14.0
Caseine, ...	26.0
Starch, ...	35.0
Sugar, ...	2.0
Gum, ...	7.0
Fat, ...	2.0
Woody fibre, ...	12.5
Mineral matter, ...	1.5

The straw of the lentil is nourishing and delicate food for young stock.

Lentils grow best on light, dry, sandy soil. If grown for fodder they may be sown broadcast; for seed they should be sown in drills, one foot apart. The cultivation should be similar to that for vetches, to which family the lentils are nearly allied. When the stems turn yellow and the pods brown, the plants should be cut and dried for two days in the sun. They should be sown when there is no longer any chance of their being injured by late frosts, and may be harvested four months after sowing. The stalks are capital food for cows, increasing the yield of milk. The small brown lentil of France is, perhaps, the best sort to grow.

LUPINE (*Lupinus albus*).

Nat. Ord. LEGUMINOSÆ.

The species of the genus Lupinus are most numerous on the western side of America from Oregon to Chili, in the subtropical and temperate parts. They are rarer in the tropics. In the Old World they belong to the countries bordering on the Mediterranean. The principal species are the following :—

[1] Treasury of Botany.

L. albus. — White lupine; a native of Mediterranean countries. An annual about three feet high, with large white flowers. Cultivated to a considerable extent in Spain, Italy, and Egypt, as a fodder-crop, for green manuring, and for the seeds, which are good food for cattle; and after the bitter principle has been removed by soaking or boiling, as food by the poorer peasants.

L. luteus.—Scented yellow lupine. Common in the Mediterranean region. A good fodder-plant, used either fresh or dry. The seeds are nearly as fattening as oilcake. An annual plant.

L. angustifolius. — A blue-flowered species, belonging to South Europe. The seed is of some value for cattle food.

L. arboreus.—A native of California; has exceedingly long roots; and the plant is of value as a means of binding loose and shifting sands. It lasts for about five years; and though seldom more than three feet high above ground, yet its roots will penetrate sand for many feet.

The most valuable feature of the lupine is its capability of thriving on the very poorest sandy soil, where almost no other plant would grow. They are all of use as a means of keeping shifting sand together and preventing it encroaching.

As a forage-crop they are sown in drills fifteen inches apart in May, and are ready to cut when the blossom appears about the end of July. On poor sandy soil, where only very inferior grass could be produced, the lupine may be utilised with advantage, and made to yield abundance of nutritious food, inferior to the forage obtained from more valuable plants grown on better soil, but superior to the produce of these plants when grown upon poor barren land. The following analysis of the lupine is taken from 'Physiology at the Farm':—

Analysis.

	Parts.
Woody stems, ...	29.5
Leaves and soft tops, ...	70.5

Composition of leaves and soft tops—*i.e.*, exclusive of woody stems—cut down in a green state :—

	Fresh.	Dry.
Water,	80.20	...
Oil,	0.37	3.42
Soluble albuminous compounds,	1.37	12.68
Soluble mineral saline substances,	0.61	5.64
Insoluble albuminous compounds,	1.01	9.35
Sugar, gum, bitter extractive matter, and digestible fibre,	3.96	36.68
Indigestible woody fibre, cellulose,	3.29	30.48
Insoluble mineral matters,	0.19	1.75
	100.00	100.00

Lupines are often employed as a green manure for the orange-tree.

MAIZE (*Lea mays*).

Nat. Ord. GRAMINEÆ.

This valuable cereal, now so widely distributed over the world, was one of the most useful plants which America gave to the Old World. It is wonderful to observe how quickly the cultivation spread to the remotest parts of the world suited for its naturalisation, for less than a century after the discovery of America maize is noticed in a Chinese botanical work. At the present day we find it cultivated from Canada to New Zealand, and from Chili to Japan. Heat does not affect it, for it is one of the regular cereal crops in equatorial countries, where it grows from the level of the sea to an elevation of 9000 feet. It only requires a hot bright summer and freedom from frost, or from warm days followed by cold nights. The climate of England is too moist and equable for its production.

More than three hundred varieties are known, which differ greatly from each other. The height of the stem is from three to eighteen feet. Some varieties mature in seven months,

others in two. Tuscarora corn contains no oil; rice-corn contains more than any other cereal. Some varieties have a small cob, others possess a large one. Some are valuable as fodder-plants, others for their grain.

The cultivation is too well understood to require much notice. The seeds are soaked, rolled in lime, and planted by means of a drill or "corn-planter." The latter instrument opens the furrow, deposits the seed and manure, covers them, and rolls the ground. The rows are from three to four feet apart, and the seed is planted at intervals of six inches in the rows. From the time the seed shows till it is two feet high, the cultivator is used frequently. The crop is reaped with a corn-cutter, and the best cobs preserved for seed. The others are shelled by a machine for the purpose. The cultivation must be thorough, and the land kept in good heart. The yield varies—from ten bushels an acre in the old land of the Eastern States, to two hundred bushels on the rich soil of Kentucky and Tennessee.

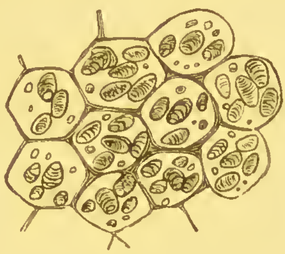


Fig. 16.—Section of cellular tissue containing starch-grains (from the seed of maize or Indian corn).

A sandy loam is the soil best suited for maize. The land must be in good heart, or the roots will spread to a surprising distance in search of food, as the plant is a gross feeder. The land must be well cultivated, but it is not necessary that cultivation should be deep. The seed is planted one inch and a half deep, and about four months pass before the plant is harvested. The small varieties may be planted in rows three feet apart, with a distance of two and a half feet between the hills, four plants being grown to a hill. Medium-sized maize should be grown in rows four feet apart, with the same distance between the hills. Four plants may be allowed to a hill. For the large Southern varieties, the rows should be from four to five feet apart, and the hills should have the same distance between them; two plants may be grown to a hill.

Maize requires a mean temperature of at least 60°. The geographical range of maize is best understood when we think that, on the American continents, from 43° N. lat. to 40° S. lat., it constitutes the chief cereal cultivation.

It is interesting to compare the relative values of the principal cereals used for food by man :—

	English fine wheaten flour.	Bran of English wheat.	Scotch oatmeal.	Indian corn-meal.[1]	Rice.[2]
Water, . . .	13	14	5	15	14½
Gluten, . . .	10	16	16	9	...
Fat, . . .	1	4	10	5	½
Starch, &c., . .	74	43	63	64	76
Fibre, . . .	1	17	4	5	1
Ash, . . .	1	6	2	2	½
Fibrin, . . .	...	...	...	...	7½

As a fodder-crop its yield is enormous. An acre of land has borne from 50,000 to 80,000 pounds of green fodder, or from 8000 to 12,000 pounds of dry feed.[3] The grain does not make good bread, and is commonly used in the forms of corn-flour, oswego, maizena, hominy, &c. The meal of the corn is exceedingly nutritious, as it contains four times more oil than wheat, more starch, and almost as much nitrogenous matter.

The stalks contain nearly as much sugar as sorghum. The result of experiments made by the United States Government[4] showed :—

	Pounds of raw stalks.	Percentage of juice in raw stalks.	Pounds of juice used.	Specific gravity of juice.	Pounds of syrup made.	Percentage of syrup in juice.
Corn-stalks, stripped and topped, . . .	2353	25.29	520	1053	74	14.23
Corn-stalks, butt ends, stripped and topped, .	2769	23.91	597	1061	101	19.92
Corn-stalks, top ends, stripped and topped, .	3568	29.04	971	1053	142	14.62

[1] Professor Johnston. [2] Ibid. [3] Ency. Brit.

[4] Report of Commissioner of Agriculture, U.S., 1878.

Proximate Analysis of Molasses from Maize and Sorghum Sugars.

	Maize. Per cent.	Sorghum. Per cent.	Sorghum. Per cent.
Sucrose, . .	32.64	33.25	22.68
Inverted sugar, .	32.93	31.81	52.79
Gum, . . .	9.08	9.77	5.51
Water, . .	21.88	21.24	16.32
Ash, . . .	4.06	4.90	3.33
	100.59	100.97	100.69

Analysis of Cane, Maize, and Sorghum.

	Sucrose.	Inverted sugar.
Tahiti sugar-cane, ...	87	6.86
Porto Rico, "	89	7.47
New Orleans, "	84	9.78
Maize from Murrysville, Pa., . .	89	7.28
" " . .	82	7.95
Sorghum from Homerville, Ga., . .	94	2.58
" Dupont, Ga., . .	91	5.08
" Murryvsille, Pa., . .	83	11.03

The stems of maize are excellent fuel. Oil is extracted from it which burns well and is a useful lubricant. The grain contains 53 to 54 per cent of starch. It is also used in the manufacture of whisky and alcohol.

Maize is grown in so many countries that it is almost impossible to give a correct idea of the total production, owing to the want of returns; the following table gives that of the principal countries where it is a staple crop :—

Production of Maize in Bushels.

	1882.	1883.	1884.	Acreage in 1884.	Export in 1884.
Russia, . .	..	18,692,227	15,602,986	..	9,889,780
France, . .	26,631,124	29,580,147[1]	28,658,495[1]	1,627,380[1] 1883.	..
Italy, . . .	72,016,134	73,313,165	..	4,240,261	..
Austria, . .	15,232,283	19,565,452	417,290 tons	875,343	..
Hungary, . .	104,201,251	84,534,024	87,548,651	4,583,414	..
United States, .	1,617,025,100	1,551,066,895	1,795,528,432	63,683,780	52,302,550
New South Wales,	4,057,635	4,538,604	2,989,585	115,600	216,956
Queensland, .	1,422,648	1,619,140	1,312,939	61,064	..
Canada, . .	..	..	..	..	3,806,474

[1] Maize and millet.

Besides which, great quantities are produced in South America, the West Indies, South Africa, Southern Europe, and Asia.

In 1880 the average yield per acre for the United States was 27½ bushels, worth 39 cents the bushel. The average return for France in 1882 was 15.35 hectolitres the hectare, valued at 14 francs 57 centimes. The United States in 1885 had 73,130,150 acres under maize, the estimated crop being 1,936,176,000 bushels, or 26.5 bushels per acre, a nearly average crop, the estimated value of which is the enormous sum of $635,674,630.

The United Kingdom imports of maize in the following years were :—

1882.	1883.	1884.
18,275,731	31,739,106	24,780,464 cwt.

In 1884, 9,018,307 cwt.. were obtained from Roumania, 8,894,960 from the United States, 3,542,634 from Russia, 1,051,847 from Turkey, 929,240 from British North America, and 660,369 from Egypt.

MILLET.

Nat. Ord. GRAMINEÆ.

The seeds of several genera of grasses have been somewhat too generally termed millets, although the plants differ considerably in form and structure. These genera, however, belong to two tribes, the Paniceæ and the Andropogoneæ, which contain a large number of plants of the greatest value to man. The following are among the most useful as seed-bearers :—

True Millet (*Panicum miliaceum*).

Said to ripen as far north as South Germany, wherever wine can be successfully produced, although it probably originated

in the South of Asia. It grows to a height of four feet. The seeds are very nutritious, millet bread being as nourishing as wheaten bread. Von Mueller says it grows at an elevation of 11,000 feet on the Himalayas.

Italian Millet (*P. Italicum*).

Cultivated in the temperate regions of the Old World from prehistoric times,[1] the origin being very obscure. Widely cultivated in India, growing to an elevation of 6500 feet on the Himalayas. The grain is most wholesome food, much thought of by the inhabitants of Eastern countries. Is most prolific; one spike will sometimes yield two ounces of grain, the produce being five times greater than that of wheat. Is a staple article of food in Japan. Will grow on light dry soil, and attains a height of four feet. In India it yields two crops in the year. In Italy it is used in soups and for feeding poultry. It is sometimes cut green for hay. In England it is used for feeding canaries.

(*P. flavidum*).

Found in South Asia, and the tropical and eastern subtropical parts of Australia. Yields a large quantity of seed.

Egyptian or Spiked Millet, Cumboo, Bajree, (*Pennisetum thyphoideum*).

Largely cultivated in India. More nourishing than rice. Cultivated in North Africa. Likes rich friable soil. In India it ripens its seed in three months, but it requires longer time to come to maturity in warm-temperate countries—probably about five months. The cultivation has been recommended for the south of France. Grows to a height of three to six feet.

[1] De Candolle, Origin of Cultivated Plants.

Sorghum, Dhurra, Indian Millet, Turkish Millet—Jowaree (Hindustani), **Cholum** (Tamil), (*Sorghum vulgare*).

The guinea-corn of the West Indies (fig. 17).

The principal food of many of the inhabitants of Asia and Africa. Cultivated in Italy, Spain, Asia Minor, and other parts of the Mediterranean regions. It is a plant of great geographical range, growing wherever maize will. Being an annual, sorghum can be successfully grown in those parts of the world where extremely cold winters are followed by very hot summers. It will ripen in insular climates where the mean annual temperature is 62°. The stem attains a height of from five to twelve feet, according to the richness of the soil. The leaves are long, and useful for forage. The seed is small and hard, yielding a white flour which can be made into excellent bread and biscuit. Sorghum is one of the most prolific cereal crops, bearing a great quantity of seed. The seed may be sown in drills three feet apart; the stalks should be grown at intervals of from three to four inches. The plant is of rapid growth. If cut green it makes capital food for cattle and horses. The stem contains a very considerable quantity of saccharine juice, and is capable of yielding sugar of good quality, though for this purpose it is probably inferior to the sugar sorghum (*S. saccharatum*).

Fig. 17.—*Sorghum vulgare*—One of the plants yielding Dhurra or Indian millet.

Sugar Sorghum, Imphee, Chinese Sugar-Cane (*Sorghum saccharatum*).

Grows to a greater height than the preceding species. The seed is not of as great importance as that of *S. vulgare*, but the

juice of the stem is very rich in sugar. Being a much hardier plant than the sugar-cane, it may be profitably cultivated in climates where the latter would not succeed. In the United States of America it is widely cultivated for the manufacture of sugar and syrup, growing as far north as Minnesota, and is considered a more profitable crop than wheat, though the yield of sugar is below that of well-cultivated sugar-cane in Louisiana. In New South Wales it has attracted considerable attention. The experiments of Mr Gillies in New Zealand prove that it can be successfully cultivated north of the Bay of Plenty.

Over forty varieties are known in the United States—Early Amber, Chinese, White Liberian, and Honduras being among the best. The land is ploughed in autumn, and made as clean as possible. Early in spring, as soon as the frosts are over, mark off the land, sowing the seed, which must be soaked previously, in drills from three to four feet apart, leaving a distance of a foot or eighteen inches between the plants. The seed should be covered with an inch and a half of soil. The crop must be kept free from weeds with the hoe and cultivator. After the plant has blossomed, the leaves may be stripped off for fodder; but the yield of sugar is diminished rather than increased by stripping. Very hot weather is apt to invert the crystallisable sugar.[1] The canes attain a height of from nine to eleven feet when mature. Shortly before maturity they often throw out suckers, which must be removed at once, as the unchecked growth diminishes the yield of sugar to a very great extent. The stalks, or canes, should be cut as close to the ground as possible, the butt-ends of the stalks containing not only more juice, but juice which is richer in syrup

[1] It is perhaps necessary to call attention to the difference between sucrose (cane or beet sugar) and invert (grape-sugar or glucose). The former is crystallisable, and is the sugar of domestic use. Grape-sugar is uncrystallisable. Grape-sugar is easily fermented, and found in the juices of many plants, generally before they are fully ripe. It may be produced from cane-sugar by the action of heat and acids. The formulæ stands: Cane-sugar, $C_{12}H_{22}O_{11}$; grape-sugar, $C_6H_{12}O_6$.

than what is yielded by upper ends. The canes should be crushed as soon after cutting as possible. Before crushing, the top or upper eighteen inches or so of the cane should be cut off.

The manufacture of sugar is conducted shortly as follows. But sugar-making on a small scale is not satisfactory; it is better to have the manufacture conducted in proper factories, where the work is better done at considerably less cost: After the crushing, the juice is heated in a copper pan to 182° F., when sufficient cream of lime should be added to give litmus-paper a purple tinge. The juice is then boiled and skimmed, when the sediment sinks and the clear supernatant liquor is run off. The sediment, equal to one-tenth to one-twentieth of the juice, is drawn off and filtered, the clear filtrate being added to the liquor, the temperature of which is meantime kept up to 150° F. The clear liquor is then run into an evaporating pan and concentrated to a syrup, being constantly stirred meantime, the lime being neutralised by the addition of sulphurous acid and water, or sulphurous oxide gas, till the liquor will redden litmus-paper. It is then run into shallow wooden troughs to crystallise.

Unless the farmer were to cultivate sugar sorghum on a large scale, it would not pay him to put up the necessary machinery and build a factory, which would probably cost at least £2000. It would be much better for him to sell his cane to some sugar factory in the neighbourhood. If he only intended cultivating enough sorghum to make syrup and a little sugar for his own and his neighbour's consumption, he could get the necessary machinery for about £60. The Blymyer Manufacturing Co., Cincinnati, U.S.A., sell a "Victor" crushing-machine for £10. The only question he will have to consider is, Can the sugar be made as cheaply as he can buy it for in the nearest town?

Where there is a local factory, the cultivation has been so far a profitable one for the farmer. "Sorghum cane will pay a farmer better than wheat, but not equal to the product of a

well-cultivated crop of sugar-cane in Louisiana. . . . Sorghum-cane growing and sugar-making may be made profitable industries in Illinois—not quite as profitable as sugar-making from tropical cane in Louisiana, but still lucrative enough to become a permanent feature in Western agriculture."[1]

The cost of cultivation of amber-cane per acre is—

	£	s.	d.
Ploughing,	0	6	0
Harrowing,	0	1	0
Marking out land,	0	0	7
Planting,	0	1	8
Rolling,	0	1	0
Seed,	0	1	3
Hoeing,	0	12	0
Cultivating,	0	8	0
Stripping,	0	4	6
Cutting,	0	6	0
Carriage—two miles to mill,	0	12	0
	£2	14	0[2]

An acre of sorghum should yield from ten to fourteen tons of canes. Canes are crushed at the factory for 6s. a ton. An acre of canes should yield from 150 to 300 gallons syrup. Syrup "has been raised and made at a cost of sixteen cents a gallon, and we think it may be done on almost any farm at a cost of not over 25 cents." Good syrup sells as high as 3s. a gallon. An acre of amber-cane, properly treated, yields 1000 pounds crystallisable sugar and about half that amount of molasses, which, like the seed, is useful food for cattle.

Sorghum sugar is yellow and nicely flavoured. The latest reports show that though syrup-making has been profitable, the manufacture of sugar has been unsatisfactory. "The successful manufacture of sorghum sugar presents greater difficulties than the working of the sugar-beet."[3] So far the industry has not paid.

[1] St Louis Republican, 30th Nov. 1882.

[2] The Farm-book.

[3] Report of the Department of Agriculture, U.S., 1883.

When the seed is in the dough, the percentage of available sugar is 1.14; when it is dry and hard the percentage is 4.14. In the seventh stage it was found to be 7.61; in the eighth stage 9.22. In the ninth stage the available sugar was 11.77 per cent, after which it fell off.[1] Hitherto farmers cut their sorghum too soon, the popularity of the early amber being attributable to its coming sooner to maturity than other varieties. The different varieties of sorghum require from eighty to one hundred and eighty days to grow and ripen.

The United States Government have taken great pains to ascertain the value of *Sorghum saccharatum* as a source of sugar, and the reports of the Department of Agriculture should be read by all intending cultivators. Somehow, the impression they leave on one's mind is that of disappointment, sorghum promising far better results than have as yet been attained.

In France, Vilmorin considered it would prove of more value for sugar than beetroot. A sandy loam is the best soil for the cultivation.

RICE (*Oryza sativa*).

Nat. Ord. ORYZEÆ.

This important grain is a native of Eastern Asia. It was cultivated in China 2800 years B.C., and De Candolle believes it to have been known in India from at least the Aryan invasion. It is the staple food of one-third of the inhabitants of the world, and may be grown where no other cereal would live. Rice, salt, and chillies are all the food an Indian coolie needs, and the greater part of the inhabitants of Asia use it as the chief means of their support.

A moist climate and a mean summer temperature of at least 74° are the necessary conditions for the growth of rice. It is cultivated in the southern and eastern provinces of Spain. It

[1] Report of the Department of Agriculture, U.S., 1881.

will grow in the extreme south of France. In Italy it grows in Piedmont, Lombardy, and to the south of these States. We also find it cultivated as a staple article of food in all the provinces of China and Japan. In the United States it is cultivated in North and South Carolina, Georgia, Louisiana, and Florida. Though, properly speaking, a plant belonging to the tropical and equatorial zones of the globe, yet, being an annual, it may be grown in subtropical countries having a tropical summer. In Ceylon it is grown up to 4000 feet elevation, the hillsides being terraced in a most wonderful manner so as to form little fields, often not more than a few feet in width, each raised above another, till the whole hillside resembles a series of steps from three to four feet in height,—a wonderful example of perseverance and labour in extending cultivation.

The systems of cultivation pursued by most tropical races are so rude that they need not be followed by Europeans. Rice is cultivated in a most primitive manner in Ceylon and the adjoining countries. The land is stirred with a bent stick for a plough, and smoothed by drawing a board over the mud; the rice is sown and reaped in equally simple ways, and finally threshed by being trodden out by buffaloes.

In the United States the cultivation is conducted thus: The fields situated on the banks of a river are usually fourteen to twenty acres in extent, and surrounded by embankments. Early in winter the land is ploughed and irrigated. In March it is dried, and brought into a fine tilth by harrowing. Trenches are laid out eight to fifteen inches apart with the trenching hoe. In April or May from two and a half to three bushels of seed are sown to the acre in these trenches, and lightly covered with soil; water is then let on till the plant is seen above it, when it is run off. When five or six weeks old the plants are hoed, and ten days after hoed again. When the rice forms its first joint in the stem, water is turned on again for some six weeks, till the crop turns yellow, when it is again let off for a few days before harvesting. The crop is cut with

sickles, and laid on the stubble to dry for a day or two; it is then tied in sheaves, and conveyed to the barn and stacked. It is threshed by a machine invented by Calvin Emmons of New York.

Rice is grown either by dry or wet cultivation. The former, known as hill or upland rice, is grown on high, unirrigated land, and cultivated like other cereals. Wet cultivation has been described.

In Italy a six-year rotation is followed. *First year*, wheat is sown after rice in the preceding October, the land receiving one hundredweight of guano to the acre, and being well worked. In spring, clover is sown through the wheat, and cut in August, after the wheat has been harvested. *Second year*, the clover is manured, irrigated, and cut three times. *Third year*, Indian corn manured with guano. *Fourth*, *fifth*, and *sixth years*, rice. For five months of the year the land is irrigated. From March to May the seed is sown broadcast, three or four bushels to the acre. The seed is usually sprouted before sowing, a practice commonly adopted in other countries. After sowing, the field is flooded to a depth of four inches, which is gradually lessened as the rice matures. The crop is cut in September or October. The straw of the rice grows to three or four feet long. Water is a heavy item in the farmer's expenses, as it costs 20,000 francs (£800) a-year to irrigate a farm of 600 acres.[1]

The rice crop of the United States for 1850 was 215,313,497 pounds, which was principally grown in South Carolina and Georgia; since then the cultivation has declined. During the war the fields fell out of repair, and afterwards the emancipated slaves showed no inclination to return to an occupation which they disliked. In 1879 the crop was 110,131,373 pounds, which was grown on 174,173 acres. The average yield of rice per acre is about 600 pounds.

In 1883 Italy had 495,766 acres under rice; the crop was 22,122,958 bushels. In 1884, 208,264,776 pounds, valued at

[1] U.S. Consular Report.

£1,058,320, were imported; and 157,568,368 pounds, valued at £1,000,900, exported. The Indian exports of rice and paddy (unhusked rice) were—in

1883, . .	31,258,288 cwt.,	valued at	£8,476,327
1884, . .	27,040,330 "	"	8,363,280
1885, . .	22,051,532 "	"	7,192,198

In 1884 Japan exported 1,353,343 cwt., worth £452,083. The same year the area under rice in Burmah was about 3,650,000 acres.

The imports of rice into the United Kingdom were—in

	1882.	1883.	1884.
	8,260,175	7,747,725	6,579,458 cwt.
Valued at	£3,297,591	3,175,426	2,679,101

The same years the exports of rice were:—

	4,008,095	3,788,677	3,436,572 cwt.
Valued at	£1,905,089	1,817,783	1,679,135

The Board of Trade calculate the consumption of rice per head of the total population of the United Kingdom at:—

1882.	1883.	1884.
13.49	12.45	9.79 lb.

SWEET-POTATO (*Batatas edulis*).

Nat. Ord. CONVOLVULACEÆ.

The genus Batatus contains about twenty species, which belong mostly to the New World, though varieties are largely cultivated in India, China, Japan, and the Malay Archipelago. Sweet-potatoes are grown in Madeira, North Africa, and the Canary Islands, but are seldom grown in the south of Europe. In the United States they are a common crop in the more Southern States, but grown as far north as Ohio, Illinois, and New Jersey; farther north the cultivation is not remunerative.

The original country of such a widely distributed plant is doubtful; some botanists believe it belongs to both eastern and western hemispheres, others think it was first found in America.

The sweet-potato has a jointed stem, of trailing or twining habit, which grows to about six feet long. When these stems rest undisturbed on the ground, they throw out roots at the different joints. The whole plant resembles the wild convolvulus. The sweet-potato is in no way related to the common potato; "the fleshy parts of the former are roots, those of the latter subterranean branches."[1]

The plant is propagated by splitting the roots lengthways; lay the halves on a hotbed, the cut side down; cover with three inches of rich light soil. The shoots are broken off as soon as they have got roots, and planted in ridges like common potatoes. The ridges should be three feet apart, the sprouts being planted at distances of fifteen inches. A slight frost is sufficient to kill the herbaceous part of the plant, when the roots should be lifted and stored under straw and earth, like the common potato. From 200 to 300 bushels can be got from an acre.

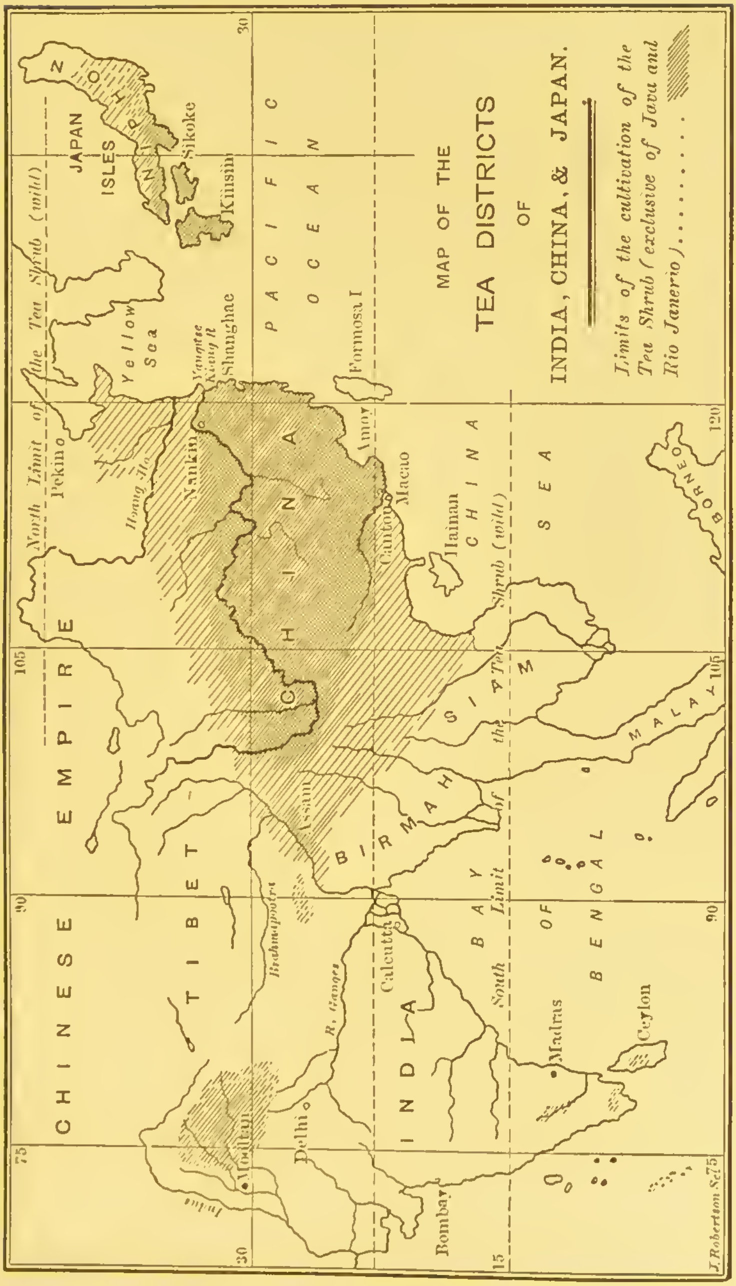
The root is excellent when baked in the embers of a fire or fried; when boiled the roots generally become waxy.

TEA (*Thea sinensis*).

Nat. Ord. TERNSTROMIACEÆ.

Tea is prepared from the leaves of two plants: *T. sinensis*, the tea plant of China, a shrub growing to a height of five or six feet with leaves about three inches in length; and *T. assamica*, the Assam tea plant, which attains a height of twenty-five or thirty feet, and has leaves about a foot long. These two

[1] De Candolle, Origin of Cultivated Plants.


MAP OF THE
TEA DISTRICTS
OF
INDIA, CHINA, & JAPAN.
Limits of the cultivation of the Tea Shrub (exclusive of Java and Rio Janerio)........
North Limit of the Tea Shrub (wild)
South Limit of the Tea Shrub (wild)
CHINESE EMPIRE
TIBET
CHINA
JAPAN ISLES
NIPHON
Sikoke
Kiusiu
PACIFIC OCEAN
Yellow Sea
Pekino
Hoang Ho
Nankin
Yangtse Kiang R
Shanghae
Formosa I
Amoy
Canton
Macao
Hainan
CHINA SEA
SIAM
BIRMAH
Assam
MALAY
BORNEO
BAY OF BENGAL
INDIA
Calcutta
Brahmapootra
R. Ganges
Delhi
Moultan
Indus
Bombay
Madras
Ceylon
75
90
105
120
30
15
J. Robertson Sc.

species have hybridised, the result being the hybrid Assam plant, which is superior to either, and is generally cultivated in India and Ceylon.

Tea is a very hardy plant (fig. 18), capable of enduring great differences of temperature (see Map). In Ceylon it grows from sea-level to an elevation of 7000 feet. At Darjeeling (lat. 27° 3′ N.) it is seen at 6000 feet elevation. In China and Japan it is cultivated as far north as the 40th degree of latitude. In the southern hemisphere it grows at Auckland, New Zealand (lat. 36° 52′). A high temperature greatly increases the yield of leaf, but tea grown at a high elevation is often considered to be superior in flavour to what is produced in hot climates. The cultivation of tea may be successfully undertaken where the mean annual temperature is from 75° to 65°, beyond which the returns will be less as the climate is cooler.

Fig. 18.—*Thea sinensis*—China Tea-plant.

Rain is of fully more importance than heat in the cultivation of tea, a yearly fall of from 90 to 150 inches of rain suiting the plant. In fact, tea requires a warm, moist, steamy climate, which will force the growth of leaves, and give the planter as many "flushes" of young leaf as possible in the course of the year. The more equable the climate, the more flushes are possible, and the return from a tea plantation in Ceylon or India is therefore greater than the return from the gardens of North China and Japan, where the winter is marked.

The tea plant will grow on almost any soil, even on poor laterite formation from which the top-soil has been washed away. It succeeds best, however, on fresh forest-land which

contains plenty of humus, a light friable sandy loam being especially favourable. If the land is rich, and not too stiff or retentive of moisture, there can be no fear about tea doing well, provided there is sufficient heat and moisture to force the flushes of leaf. The presence of iron in the soil is considered advantageous by many planters. Stony land is good, but large masses of rock may interfere with the course of the tap-root and injure the plant. The land is better drained when it has a slight slope: very steep land is more subject to wash, and a steep estate will not last so long as one on slightly sloping or undulating ground.

It is a great mistake to open too large fields of tea or coffee. Fifty acres is as much as should generally be planted in one field; but the planter must use his own judgment in this, leaving belts of forest on all ridges to protect the trees from high winds, which otherwise would sweep over the plantation, stripping the trees, and often destroying all hope of success by their uninterrupted course. When once belts of forest are neglected in the false economy of endeavouring to increase the acreage of the estate, it becomes a difficult, even an impossible matter to replace them by planting Eucalypti or Grevilleæ. Opening large areas of forest often changes the course of wind-currents; and many an estate in Ceylon has been ruined by neglecting to leave these sheltering belts, which can be cut down afterwards if they are found to be of no use. These forest-belts mitigate the attacks of insect-pests, and improve the appearance of an estate immensely.

Whenever the land has been felled and burnt, the first operation is to cut suitable roads through the clearing, leading to the factory, bungalow, and coolie lines—the future sites of which must be selected as soon as possible. These roads should be four feet wide, sloping inwards, with a shallow drain cut along the inner side. A shallow drain is preferable to a deep one, as the depth of the drain is increased by the flow of water and the periodical cleaning of the drain. For tracing roads and drains there is no better instrument than the "road

tracer" patented by Messrs John Walker & Co. of Colombo, which costs about Rs. 20, and is simple, handy, and accurate. It is also supplied by Messrs Walker Bros. of 88 Bishopsgate Street, London.

Tea is usually planted in rows four feet apart, with a similar distance between the plants, which allows 2722 plants to the acre, and is a favourite distance for hybrid Assam plants, though Chinese plants may be planted closer together, say $3\frac{1}{2} \times 3$ feet. Supposing the clearing is to be planted 4×4 feet, it is necessary to have a long rope with marks of red cloth inserted between the strands at regular intervals of four feet. Both ends of this rope should be tied to stout stakes five or six feet long. Run a straight line across the field with a prismatic compass in the direction which you wish the lines of tea to take. Then follow with the marked rope, which is stretched along the line you have marked out with the compass, and a wooden peg inserted in the ground at each of the four-feet marks. Should the rope be raised above the ground by the branches of half-burned trees, &c., the position of the pegs may be accurately found by holding a round stone to the marks, dropping it, and inserting the peg at the place where the stone strikes the earth. The stakes at the ends of the rope must be held by steady responsible men. Boys can drive in the pegs, but the work requires constant supervision, as the appearance of the clearing depends upon it. When pegs are placed at all the marks, drag the rope along the line to the last peg, and repeat the operation till the line is finished. You will then have a straight line of pegs, four feet apart, running across the clearing. The men at the ends of the rope then lay sticks, four feet in length, at the end of the line and at the end of the rope, and measure off another line four feet from the first. See that the line is straight, and not diverted by stumps or logs in its course, the overseer or *cangany* having a four-feet stick in his hand to check the distance from the main line. When it is right, drive in the pegs as before, and repeat the operation till the clearing is all marked out.

Holing is the next operation. This is done by gangs of

men armed with straight crowbars three and a half feet long, flattened out at one end, called *alavangas* in Ceylon, and *momoties* or hoes. The coolie marks a circle eighteen inches in diameter round the peg, and cuts the hole out as deep as the *momotie* will go, finishing the hole with the crowbar. The earth taken out is piled on the lower side of the hole. The holes are eighteen inches diameter at the top, and are eighteen inches deep, but only about six inches wide at the bottom of the hole. On free soil a Tamil coolie will cut one hundred such holes in a day. Some planters prefer nine-inch holes for seedlings. On steep land the holes should be cut from the top of the hill downwards, to prevent them from getting filled up with falling stones and earth. After these holes have been exposed to the air for a few weeks, they are filled up by women and children, who scrape in the rich top-soil, rejecting stones and sticks, leaving the holes loosely filled with earth for about six inches above the surface of the ground. The peg is then replaced in the centre of the mound, and the soil left to settle.

The nursery should be near a stream of water. The earth must be well broken up to a depth of eighteen inches, and all roots, stones, &c., removed. It is then laid out in beds five feet wide. The tea seed is planted in rows across these beds, a coolie being on either side marking the line with a piece of cord. The seeds are buried one inch deep and two inches apart, three inches being left between the rows. The beds are frequently watered, and are sheltered by running forked sticks down the sides of the bed. Across these straight sticks are laid, resting in the forks, over which a few leafy boughs are placed. The shade should be at least three feet above the surface of the ground. The nursery beds are carefully weeded by hand. When six months old, seedlings are ready to transplant. The soil around them is watered, and then loosed with a pronged fork, the plants being carefully lifted with as much earth adhering to the roots as possible. They are laid in broad shallow baskets, and conveyed to the field.

Planting takes place in wet weather after the soil has been

exposed to two or three days of steady rain. The coolie has a small basket of plants with him. He withdraws the peg from the hole, drives his *momotie* or hoe down to the head in the centre of the mound, and draws the soil towards him, inserting the young plant at the back of the blade, and carefully arranging the earth round the roots, taking special care not to bend the tap-root. He gently removes the *momotie* out of the soil with his left hand, while he supports the plant with his right, and tramples the earth round the plant, replacing the peg to mark its situation. It is necessary to go over the field once, or oftener if necessary, to supply vacancies, after which the field is hand-weeded once a-month for the next year, when all vacancies are again supplied with fresh plants. A dull day of steady gentle rain is the best for planting; heavy rain prevents the men from working properly, and cakes the earth in the holes. In order to ensure the tap-root being straight, the plant should be placed rather deeper in the hole than is intended, and after the earth has settled round the roots, it should be raised till the collar is level with the surface of the earth. Tea may also be planted at stake, three seeds being dropped in a hole. This saves the trouble of nurseries, but the plants have more dangers to encounter in their infancy.

As soon as the clearing is planted it should be drained. It is even advisable to drain before planting, as heavy rains wash away much of the best soil. The drains are traced with the road tracer, and should have a fall of one foot in fifteen to one foot in twenty-five. Keep all your drains at the same gradient. If the drain is to fall into a ravine, commence at the edge and trace its course at, say, one in fifteen upwards, a coolie fixing a peg of wood at every observation, which should be about twelve feet apart. Never trace too long drains, or they will be apt to burst. Great difference of opinion exists as to the distance between drains. I found forty-eight feet a very convenient distance. Where there is no natural outlet for the drains, it will be necessary to cut a receiving drain two feet broad and eighteen inches deep, running straight up the hill, into which the side drains can run. But do not let the side

drains empty themselves into the receiving drain opposite to each other; keep them alternate to avoid wash. Drains should be eighteen inches broad and one foot deep in the solid earth. A coolie can cut a chain a-day. These drains must be cleared before and after periodical rains. In cutting the drain, a line should be scratched in the earth two feet above the pegs, and the drain should be cut above the row of pegs, which should remain along the lower edge of the drain. All earth must be thrown well out on the lower side.

Where wind prevails, tea must be staked in the same manner as coffee.

When fifteen or eighteen months old, tea is topped evenly across at eighteen inches high, so as to leave a flat surface. This is done to make the plants grow as bushy as possible, by encouraging the growth of the lateral branches. After topping the more vigorous shoots which grow above, the others may be nipped back.

Pruning must not be severe; the garden should always be kept in such order that a light pruning only is necessary. This is better understood by remembering that plucking is but a continuation of pruning. The main objects of pruning are: to give the trees as large and even a surface as possible, and to develop the growth of leaf. The more nearly the plant resembles the Assam, "the more sparing one must be with the knife."[1] At the second pruning cut the plant straight across, leaving a flat surface. Thereafter remove all cross wood, lanky whippy branches, hardwood or *bangy*, flowering wood, and white-barked branches, and keep the top of the bush even. In India tea is pruned in the cold season; in Ceylon during the south-west monsoon, from June to August.

The system of pruning recommended by Mr Armstrong[2] is to top higher when the garden is above 3500 feet elevation, as the growth is not so strong as it is on lower and warmer estates. When the plants are about three feet high, he sends

[1] Tea Encyclopædia, 1882.

[2] Tea Cultivation in Ceylon. C. S. Armstrong. A. M. & J. Fergusson, Colombo. London: J. Haddon & Co., Bouverie Street, E.C. 1s.

boys round with thirty-inch sticks to nip off all shoots above this height. At eighteen months, when the bushes are getting shrubby, cut them across with the knife at eighteen inches, and when the flush gets up to thirty inches, nip off all buds at or above this length. When from two to two and a half years old, knife-top the plants again at twenty-four or thirty inches, according to elevation. At three or three and a half years old, top at two and a half or three feet. The trees are then in shape, and require very little pruning for four years, beyond keeping the surface of the bush flat. At four to four and a half years, tea over 3000 feet elevation is topped at three feet three; at five years, at three feet six; at six years, three feet nine; at seven years, from three feet six to three feet nine; at eight years, cut down to two feet six or three feet, according to elevation. All "crow's-feet" and white-barked whippy branches are cut out, and as much red wood as possible is left.

After pruning, numerous young shoots appear which develop six or eight leaves each. The lower of these throw out shoots from their axils, which become foliated, and in their turn develop new shoots. About a month after pruning, when the axillary bud which forms the second flush has got a start, plucking begins by nipping off the tip, first leaf, and half the second leaf of the first flush; the base of the half leaf is left to protect the bud, which in time forms a fresh shoot. Two fully developed leaves should always be left on the shoot. For the first few months of the year pluck carefully to get good wood on the trees, and do not take anything below the desired height of the bush. Towards the end of the year the tip and two and three-quarter leaves may be removed; at the end of the year take all you can get. In plucking make the coolies nip the leaf through with the thumb-nail, and on no account let them tear off the last leaf, or much loss will occur. The time in which it is necessary to go round an estate varies with the elevation, and is usually from seven to twelve days. The coolie puts the plucked leaf into a cooty sack tied round his waist, which he empties when full into cane or bamboo bas-

kets shaped like truncated cones. Tea under eighteen months old should not be plucked. A good coolie can pluck from thirty to forty pounds when there is a good flush.

When the leaf is brought in, it is "withered" by spreading it thinly on shelves in an airy place till it is flaccid and has a soft feel. The process can be effected by putting the leaf in the sun, or artificially over a fire.

Rolling may be done by hand upon a table, or by a machine for the purpose. In the former case, the coolie takes as much leaf as he can conveniently manage, and rolls it from and towards him with both hands till the juice of the leaf is expressed and the leaf has a good twist. It takes about twenty minutes to do. Opinion differs as to whether the leaf should be rolled light or hard; some combine the two, and begin gently and finish hard. Coarse leaves, &c., may be picked out during the process.

When sufficiently rolled, the leaf is made up into balls or cones and placed under a blanket to ferment till the leaf has a fresh pleasant smell and the mass becomes copper-coloured. Fermentation depends greatly upon the temperature. In warm weather the process may be completed in twenty minutes; in cold weather it may require some hours. It is recommended to hand-roll lightly again after fermentation, to ensure the leaf retaining its twist.[1]

The furnaces are of brick, thirty inches high and three feet square at the top; they are shaped like the letter V, and are about fourteen inches wide at the grate, with an opening for the admission of air. Trays are made to fit over the furnaces, the bottoms being of fine wire-gauze. The roll is broken up and spread thinly over the gauze of the tray, being constantly removed and turned; in about a quarter of an hour the tea is passed through a No. 8 sieve, and the operation repeated using a No. 6 sieve; the residue is replaced over the furnace, and finished in ten minutes, when the tea should be crisp; but much experience is required to tell when it is properly fired.

[1] Tea Cultivation in Ceylon. C. S. Armstrong.

The siftings are finished subsequently. Firing checks the fermentation of the previous process. The fires should be bright, but care must be taken to prevent the tea burning.

Next morning the tea is tasted and classed. It is then sorted by women, and sifted through sieves of different sizes, after which it is put in the bins ready for packing.

Among machines used in the manufacture of tea, Jackson's "Universal" roller is recommended by Mr Armstrong for small gardens; for larger ones, Jackson's "Excelsior" is said to work up to 8000 pounds of leaf a-day. Kinmond's "Centrifugal" is also well suited for fine teas. By using these machines much manual labour is saved, the tea ferments quicker, and can be produced at a cheaper rate; but they do not altogether do away with hand-rolling, which gives a better finish to the leaf. Davidson's "Sirocco" and other machines supersede the old system of charcoal-firing, giving better and cheaper results. Sifters are also to be recommended on the score of economy. By the use of these and similar and later machines, the cost of manufacturing tea is lessened by 1½d. per pound.

Tea is manured in much the same way as coffee, similar manures being used. If possible, it is better to apply the manure by means of forks. Salt is said to be a valuable manure.

The yield of tea varies with the age of the plant and the season. In Ceylon, tea in full bearing has given as much as 1200 pounds per acre, a most wonderful crop. Mr Armstrong[1] gives his results from land between 4700 and 5600 feet elevation in Ceylon:—

At 2½	to 3½	years old	165	pounds	of tea per acre	
" 3½	" 4½	"	292	"	"	
" 4½	" 5½	"	262	"	"	heavily pruned.
" 5½	" 6½	"	450	"	"	
" 6½	" 7½	"	700	"	"	will be exceeded.

Ceylon and Southern India seem likely to become very

[1] Tea Cultivation in Ceylon. C. S. Armstrong.

great tea-producing countries—the quantity of tea produced per acre being more than is obtained in North India and China, and the abundance of cheap labour gives them a great advantage over those parts of North India where labour is imported.

China is the principal tea-producing country in the world, the quantity exported being four times as much as is exported from India; and when we consider that it is the common beverage of the country, the production must be enormous. Fortune says the chief tea-districts are situated between 25° and 31° N. lat. Japan exports a large quantity of tea, principally to the United States. Mr Van Buren, in a consular report to the United States Government, estimates the tea crop of 1878 at 60,000,000 pounds, which is grown generally on the sides of the hills, and is often adulterated with leaves of the Wisteria. He states the daily wages of a tea-pruner to be 1s. 3d. to 1s. 5½d., rollers and firers 7½d. to 1s. 3d.

India shows a rapidly increasing production of tea. In 1870 the export was 12,754,022 pounds, which in 1885 increased to 65,147,897 pounds. In Ceylon, the failure of coffee, owing to "leaf-disease," has compelled the planters to turn their attention to tea: this they have done with great success, producing tea of superlative quality. The demand for Indian and Ceylon teas is rapidly increasing, while the export of China tea is waning, the high quality of the former being everywhere admitted. And these teas, produced by British capital and the labour of British subjects, seem likely to replace the China teas, which are so frequently adulterated.

Exports of Tea in Pounds.

	1880.	1881.	1882.	1883.	1884.	1885.
China, . .	279,615,600	284,996,266	268,953,060	264,943,466	268,828,933	..
Japan, . .	..	..	31,373,501	32,107,595	30,901,173	..
India, . .	38,405,632	46,918,539	49,255,342	58,233,345	60,473,113	65,147,897
Ceylon, . .	103,621	277,590	623,292	1,522,882	2,262,539	3,796,684

In 1884 Russia imported 35,604,000 pounds of tea; Denmark, 820,539 pounds; Holland, 3,901,080 pounds; and the United States, 67,666,000 pounds. Among British colonies, New South Wales imported 8,437,981, and exported 700,195 pounds. Victoria imported 11,524,205, and exported 4,977,489 pounds. South Australia imported 2,229,993 pounds. New Zealand took tea to the value of £180,301. Queensland imported 2,757,277 pounds; Cape Colony, 1,295,042 pounds; Canada, 15,718,442 pounds; Newfoundland, 765,374 pounds; and Tasmania, 456,099 pounds.

In 1884 the total imports of Australia and Tasmania, less exports, were 19,727,871 pounds, and the population of the colonies was 2,635,779, giving 7.4 pounds of tea per head of the population. In Canada the consumption was 3.6 pounds per head. The Board of Trade give the consumption in the United Kingdom, per head of the total population, at :—

	1870.	1882.	1883.	1884.	
Tea,	3.81	4.67	4.80	4.87	lb.
Cocoa,	0.20	0.34	0.36	0.39	"
Coffee,	0.98	0.88	0.89	0.90	"

During the last three years of the returns the imports and exports of the United Kingdom have been :—

	1882.	1883.	1884.
Imported, . .	210,663,133	222,262,431	213,877,759 lb.
Value, . .	£11,043,884	11,542,931	10,494,953
Exported, . .	38,554,177	42,733,234	45,526,833 "
Value, . .	£2,363,689	2,394,805	2,487,468
Retained for consumption, .	164,958,230	170,780,777	175,060,301 "

In 1884 the imports of tea into Germany were about 4,000,000 pounds, and those of France about 500,000 pounds.

CONDIMENTS.

CAPERS (*Capparis spinosa*).

Nat. Ord. CAPPARIDACEÆ.

A TRAILING shrub, belonging to the south of Europe and Mediterranean regions, where it is cultivated for its unexpanded flower-buds. It is grown in Italy, Sicily, Malta, and in the south of France about Marseilles.

It is a tender plant, unable to bear much cold, and easily cut down by frost, though the roots may throw out fresh suckers the following spring. It grows best on dry rocky places and on old walls, where the heat of summer is not excessive. Where the summers are hot and dry, it likes a fresh deep soil, or light land under irrigation; but it will not grow on wet land, and must have plenty of light and sunshine.

It is grown from cuttings ten inches long, planted in spring in the nursery. At the beginning of winter, the shoots thrown from these cuttings are taken off, the plants are covered with earth, and put out the following spring. It may be also propagated by heaping earth round the stem of the plant in spring. The shoots which spring from the lower part of the stem are removed when rooted. Capers are also grown from seed and from pieces of root.

In October the branches are cut back to about eight inches

from the stem, and the stems covered a fortnight after by little mounds of earth. These mounds are removed in spring, the old wood is taken off, and the stems are lightly covered with soil once more. Soon after, new branches shoot out from the earth, the best of which are preserved. The land is tilled in December and early spring, and the trees are manured after the first tilling.

About the second year after planting, the first buds are gathered, care being taken to remove as little as possible of the footstalk. They are picked every week at first, but they have to be picked much oftener when the season is at its height. As the flower-buds are picked, all withered flowers and fruit are taken off the plant, so as to leave all its power for the production of buds alone.

The gathered buds are passed through sieves to divide them into five sizes, the most valuable of which are known in France as:—

1. Nonpareille, or the smallest and most valuable buds.
2. Capucine, rather larger than the above.
3. Capote, rather larger than the Capucine.

The object of the cultivator is therefore to pick his buds as small as possible.

After sorting, the buds are dried on sheets for one day. When slightly withered, they are put into casks of the best vinegar, so as just to soak the buds,[1] and a light weight is laid over them to keep them from floating. Sometimes they are put first in vinegar and salt, and afterwards in pure vinegar. The fruits, when pickled, are sold as gherkins.

Capers thus preserved have antiscorbutic and stimulating properties, and are a well-known condiment. The large pinkish-white flowers are a handsome addition to a garden. The produce of a caper plant is about five pounds of buds yearly.

The caper requires a mean annual temperature of at least 62°. The winter must be mild, and the summer hot and dry.

[1] Du Breuil.

A rather higher temperature will suit it better, and be more likely to provide the conditions required by the plant.

The fruits, known as *cornichons* in France, are pickled.

CAPSICUM (*Capsicum annuum*).

Nat. Ord. SOLANACEÆ.

The fruits of the Capsicum, usually called chillies, are much employed in cooking, for making pickles and sauces, also in the manufacture of cayenne pepper, and in medicine. Numerous species exist, the best known being—

1. *C. frutescens.*	Goat or spur pepper.	A native of India.
2. *C. annuum.*	Guinea pepper.	
3. *C. baccatum.*	Bird pepper.	E. and W. Indies.
4. *C. grossum.*	Bell pepper.	
5. *C. cerasiforme.*	Cherry pepper.	
6. *C. tetragonum.*	Bonnet pepper.	West Indies.
7. *C. fastigiatum.*		East Indies.

Though plants belonging originally to the tropics, they do not require a very warm climate. They fruit freely at 5000 feet elevation in Ceylon, where the mean annual temperature is 65°; but they are easily killed by frost. Some sorts fruit at Auckland, New Zealand, where the mean yearly temperature is 59°. They grow freely in the warmer parts of South Europe; but they require a hot climate to bring out their full pungency and flavour.

They are annual or biennial plants, growing to about three feet high. The seeds are sown in boxes of light rich mould, and pricked out when two inches high. The seeds keep well in their pods.

Cayenne pepper is made by drying the ripe fruit in an oven, pounding them in a mortar, and grinding them to a fine powder. The pepper must be kept in tightly corked bottles.

The powder, after coming from the mill, is sometimes mixed with flour and made into biscuits with leaven, baked till quite dry, and then ground and sifted. Too often cayenne pepper is composed of red-lead and other deleterious substances.

Chilli vinegar is made by putting a number of chillies into a bottle and filling it with vinegar. It is fit for use in six weeks' time.

Bird peppers, sliced shallots, sliced cucumber, and a little lime-juice put in a bottle and filled up with Madeira wine, form a West Indian relish and stomachic.

Cayenne pepper promotes digestion, and is therefore a useful ingredient in tonics and stimulants. It is used in cases of dyspepsia, flatulence, and in lethargic affections. It acts powerfully on the liver; but, when used in excessive quantities, is apt to produce affections of the liver, especially in hot climates, though in small quantities it stimulates the action of the liver. Residents in the West Indies usually have a few chillies or peppers on the table at breakfast and dinner, eating them with meat or fish as a necessary and highly stimulating relish. The natives of India and Ceylon eat them largely in curry, and consider them very wholesome and stimulating. As most of the natives belong to non-drinking castes, they find chillies supply the place of alcoholic beverages. The mistake Europeans in hot climates often make is in using hot highly seasoned dishes containing large quantities of chillies or red pepper, and taking alcohol as well. An excellent gargle is made by boiling a tablespoonful of cayenne pepper or chillies in a half-pint of vinegar, adding a little salt, and straining. A capital blister or counter-irritant is obtained by soaking a piece of rag in alcohol or vinegar, dusting it plentifully with red pepper, and applying it. In medicine the dose of powdered Capsicum is from one to five grains. In large quantities Capsicum is an irritant poison.

The value of Indian chillies in January 1886 was from 38s. to 45s. the hundredweight in the London market.

FENUGREEK (*Trigonella fœnum-græcum*).

Nat. Ord. LEGUMINOSÆ.

Probably a native of India, but naturalised in Greece at a very early period. Is an annual of erect habit, about two feet in height. Cultivated to a considerable extent in India, and rarely in England, where the climate is too cold for it. The leaves are formed of three obovate leaflets, of which the middle one is stalked. The pod is sickle-shaped, and contains from ten to twenty seeds, which yield a bitter fetid oil.

The seeds of fenugreek, formerly of high repute as a medicine, are now only used by veterinary surgeons. The powerful aromatic odour of the seeds makes them used to flavour cattle-foods. When bruised they were formerly used as cataplasms in rheumatic affections and ulcers. In curry-powder fenugreek-seeds form an important ingredient. For feeding domestic animals the seeds are coming into use, one part fenugreek-seeds being mixed with three parts maize or rice-meal. Egyptian seed is now obtainable in England for £4, 10s. a ton; formerly the price was three times that sum.

A writer in a recent number of the 'Field' gives the analysis of fenugreek-seed as follows:—

Moisture,	8.87
Oil,	7.40
[1] Albuminous compounds, flesh-forming matter,	27.75
Mucilage, sugar, and digestible fibre,	41.98
Woody fibre (cellulose),	7.13
Mineral matter (ash),	6.87
	100.00
[1] Containing nitrogen,	4.44

Fenugreek is grown to some extent in the Mediterranean regions. In India it is grown as a fodder-plant.

GINGER (*Zingiber officinale*).

Nat. Ord. ZINGIBERACEÆ.

A native of India. Introduced into Jamaica by a Spaniard, Francisco de Mendiza, and naturalised throughout tropical America. It consists of a jointed root or rhizome, which throws up numerous reed-like stems about two feet and a half in height, with long narrow lanceolate leaves. The flower-stalk rises from the root and terminates in a cone-shaped scaly spike. It is tolerably hardy, but will not stand much frost. It grows to an elevation of 5000 feet on the southern slope of the Himalayas, and may be grown in an equable climate where the mean annual temperature is about 65°. It grows at Auckland, New Zealand, as a garden-plant.

It is propagated by dividing the roots. These are planted in spring in deeply cultivated land, laid out in beds, and covered with about three inches of soil. Towards the close of the year the stems die, and the roots are dug up, scraped, washed in hot water, and sun-dried for several days. They are bleached in the fumes of burning sulphur, or by dipping them in a solution of chloride of lime. When the outer skin has not been removed it is called "coated" or "black" ginger. It is a very exhausting crop, soon wearing out the soil it grows in. When the pieces of root are planted, the beds may be covered with leaves to keep the ground moist, over which a covering of manure is spread. The plants should be about one foot apart. In a good year an acre of fresh land yields about one hundred and forty pounds of root, according to Bryan Edwards. The price of fine Jamaica root is from £5 to £12 per hundredweight.

In medicine ginger is much used in cases of flatulence and dyspepsia, and spasms of the stomach. Ginger-tea is made by infusing green ginger, or fresh root, in boiling water, and drinking a cupful as hot as possible. It is a simple and most effectual cure for indigestion.

Essence of ginger is made by digesting three pounds ginger in five pints rectified spirit for fourteen days, and reducing the strained tincture by distillation to one quart; it is then filtered and bottled.

Syrup of ginger. Infuse two and a half ounces bruised ginger in one pint of boiling water for twelve hours, subjecting it to pressure. In the cold stages of jungle-fever the Cingalese drink a cup of very hot coffee and bruised ginger to produce perspiration. It is very effective, and may also be used in cases of chill.

Bruised ginger is used as a poultice to remove foreign bodies, such as thorns, from the skin.

Ginger is a most useful aromatic stimulant for people of weak digestion; it is both safe and pleasant to take.

Preserved ginger is made from the young rhizomes, dug up when the stalks are about six inches long and the rhizomes are tender and full of sap. The roots are first scalded, then washed in cold water, and the outer skin peeled off. It takes three or four days to prepare the roots to perfection, and the water is frequently changed. When quite clean the roots are put into jars of weak sugar-and-water. In a day or two this syrup is removed and a stronger syrup added. This is done four times. The removed syrup may be fermented and drunk. Honey may be added to the last syrup.

Ginger, especially the young fresh rhizomes, is one of the ingredients of curry.

The present London market values of ginger are: Bengal, 20s. to 20s. 6d.; Cochin, medium to bold cut, 70s. to 103s. —ordinary to good rough, 32s. to 46s. per hundredweight; preserved China, 4d. to 6d. a pound.

MUSTARD (*Sinapis nigra*).

Nat. Ord. CRUCIFERÆ.

Numerous species of the genus Sinapis yield seeds of considerable value to man. Among the most cultivated are :—

S. nigra.	Black mustard.
S. alba.	White ,,
S. juncea.	Indian ,,

The first of these is the variety which yields the most pungent mustard, and is therefore mostly used by the manufacturers of that condiment. It is grown over a large extent of the surface of the world, from India to Yorkshire. It requires rich alluvial land, and is an exhausting crop. White mustard is also used for making the condiment, but it does not possess the same pungent oil which is contained in black mustard, and is only used when mixed with the seed of the latter. It is generally used as an addition to salads. It is a good forage crop, about a peck of seed being sown broadcast to the acre. In two months' time sheep may be folded upon it. Used thus, or for ploughing in as a green manure, it is generally sown after an early crop of corn. When grown as a manure it should be ploughed in before the flowers burst. Used in either of the above ways it is of great benefit to the land. The Indian mustard is of a brown colour, and is often mixed with black mustard for making the condiment. Used alone and mixed with vinegar, after being roughly ground, it is, to my mind, far superior to any preparation of mustard for table use.

The cultivation of black mustard for seed is usually carried out on land when first broken up from grass. The land is ploughed to a moderate depth in March. From half a peck to a peck of seed is sown broadcast about the end of April, and lightly harrowed so as just to cover the seed. In May the land is hoed and weeded. The crop is cut when the

lower pods begin to turn brown. The plants are tied in sheaves and stooked, when the succulence of the stems will complete the ripening. The seed is threshed out, over sail-cloth, in the field. The seed should be of a bright red-brown colour. Rain will damage the colour of the crop. The return from an acre is from twenty to forty bushels. It is a most profitable crop when successfully grown.

In the preparation of the condiment the seeds of the black and white varieties of mustard are mixed, according to the fancy of the manufacturer; they are then crushed between rollers, pounded in mortars, and sifted. The matter left in the sieves, called "siftings" or "impure flour of mustard," is again sifted, and the best of it probably added to the better quality of flour of mustard. Flour of mustard is often adulterated with wheaten flour, capsicums, chromate of lead, and turmeric,—the capsicum being added to give it pungency, and the lead or turmeric to colour it. French mustard is seasoned with Tarragon vinegar, garlic, celery-seed, and cloves. German mustard is mixed with vinegar, in which black pepper, spices, and onions have been boiled.

The siftings of the ground-seed are pressed, on account of the oil contained in them. The seeds are seldom, if ever, pressed only for oil in England; though in other countries —India, for example—the seeds are cultivated principally for the oil. The seeds of the black mustard yield 23 per cent of oil; those of white mustard, 22 per cent; and those of Indian mustard, *S. juncea*, 20 per cent. Mustard-oil is of a yellow colour, mild-flavoured, and inodorous. It is a fixed oil. In India mustard-oil is used for burning, anointing the body, and cooking.

Black mustard is a strong acrid stimulant, owing its pungency to an essential oil which does not exist separately in the seed, but is the product of two substances — myrosin and sinigrin—when acted on by cold water. In white mustard-seed the leading principle is sinalbin, which resembles sinigrin to a certain degree.

Taken in small quantities mustard promotes appetite and assists digestion. Larger doses, say one or two teaspoonfuls, rouse the gastric juice and act as an emetic. Excessive doses are followed by vomiting, purging, and inflammation of the bowels. Rightly used, mustard is an excellent condiment, aiding persons with torpid digestive organs to assimilate indigestible food.

SOY-BEAN (*Soja hispida*).

Nat. Ord. LEGUMINOSÆ.

A small annual hairy plant, a native of the north of China and Japan. It resembles a dwarf kidney or French bean. The flowers are small, and violet or yellow coloured. They are followed by oblong, hairy pods, containing from two to five seeds about the size of small French beans. The cultivation of this plant is chiefly carried on in the north of China, in the province of Shantung.

The beans are mixed with an equal quantity of coarse wheat or barley-meal till nearly dry; sugar is then added, and the vessel is covered and left for twenty-four hours in a warm room to ferment. To the paste is then added as much salt as there is paste; it is put into jars and water poured over it, and is stirred daily for from two to three months. The liquor is then poured off, strained, and bottled, or it is clarified by boiling, and skimming before bottling. It becomes brighter and clearer by keeping. It is one of the principal ingredients in almost all European sauces. Chinese soy sells at from 2s. 3d. to 3s. a gallon, and Japanese at 2s. 4d. to 2s. 5d. It is said to promote digestion.

The plant is also cultivated for the oil contained in the seeds, which amounts to 17 or 18 per cent. The oil has a pleasant taste and smell, and is used for culinary purposes, burning in

lamps, and as a drying oil instead of linseed. The cake is used for human food and for fattening cattle.

The plant is hardy, growing like the ordinary French bean, and requiring about the same climate to ripen in, or one only slightly warmer. The soy-bean has been grown in Austria and Germany. It would probably ripen in a country where the summer isotherm for July was 72°.

Soy fetches 1s. 6d. to 1s. 7d. a gallon in London.

VEGETABLE WAX AND TALLOW.

CANDLEBERRY MYRTLE (*Myrica cerifera*).

Nat. Ord. MYRICACEÆ.

A NATIVE of the United States, where it is sometimes called "barberry." Grows in wet soil, particularly near the sea. The berries, which are about the size of peppercorns, are gathered late in the autumn and thrown into a pot of boiling water; the wax exudes, floats on the top, and is skimmed off. The wax is again melted, and when refined is of a clear green colour, with an aromatic smell, and in its nature something between wax and tallow. The berries yield about a quarter of their weight of wax. Mixed with tallow, it makes good candles, which burn well, with an agreeable odour. A soap is also made from the wax. The Candleberry myrtle is from three to eight feet high. It has been introduced into France, where it is more thought of than in its native country.

CHINESE TALLOW-TREE (*Stillingia sebifera*).

Nat. Ord. EUPHORBIACEÆ.

The fruit of this tree is about half an inch in diameter, and contains three seeds, which are thickly coated with a substance

like fat, which yields the vegetable tallow. The process is thus described by Mr Fortune: The seeds are picked in November and December, at the beginning of the cold weather, when all the leaves have fallen. They are separated from the stalks and shelled, put in a wooden cylinder, which is open at the top, and has the bottom perforated with holes. This is placed over an iron vessel of the same diameter, and six or eight inches deep, containing boiling water, so that the seeds are thoroughly steamed for ten or fifteen minutes. They are next pounded in a mortar to detach the tallow from the seeds, after which they are placed on a sieve and heated over a fire; the tallow passing through the sieve is collected in metal basins. The process from the steaming is repeated a second time, to secure all the tallow possible. The tallow is thus separated from the seeds, which are afterwards ground and pressed for the oil contained in the kernels, as we shall presently describe, and now resembles coarse linseed-meal. It is put between rings of twisted straw-rope, five or six of which are laid over each other, forming a hollow cylinder. These are pressed in a wedge-press, the tallow being caught in a tub placed beneath. It is a beautiful white semi-liquid, but requires to be mixed with wax to give it firmness for candles.

The wood of the tree is hard and close-grained, and used in China for printing-blocks; the leaves are used for dyeing black.

After the tallow has been extracted from the seeds, the latter are ground and winnowed; the clean kernels, after being steamed, are crushed into meal, steamed, and pressed. The oil is used for burning, toilet purposes, varnishing paper, umbrellas, &c., and medicinally. The marc is a good manure, especially for tobacco. The husks and refuse are used for fuel. The yield of tallow from the seeds is from 20 to 30 per cent of their weight—the yield of oil from the cleaned kernels being about 30 per cent. The tallow melts at from 90° to 111° F. The *Stillingia sebifera* grows principally in the provinces of Chekiang, Kiangsee, Hoopih, and the Chusan

Archipelago; lat. 32° N. seems to be its northerly boundary. It grows at Sydney.

JAPAN VEGETABLE WAX, JAPANESE URUSHI
(*Rhus succedanea*).

Nat. Ord. ANACARDIACEÆ.

Several species of Rhus yield this substance, the species under notice being the most important. It grows abundantly in the south-west provinces of Japan, as far north as lat. 35°. It grows in the Sydney Botanical Gardens. It is also obtained from *R. sylvestris* and *R. vermicifera*. All three species are small trees or large bushes.

R. succedanea is often planted round fields at distances of three feet. When grown in plantations the trees are planted 6 × 6 feet apart. It grows in any soil, and is propagated by seeds or cuttings. The trees are topped to keep them of a convenient size, and pruned into pyramidal shape. They blossom in June, and the fruit is picked about the beginning of November. The berries resemble clusters of small peas.

When gathered, the clusters are sun-dried for a few days, and may be kept in straw till wanted. The berries are separated from the stalks by threshing with bamboo flails. The wax is contained in the pulp round the seeds, and is extracted thus: The berries are put in a wooden mortar and well pounded to separate the pulp from the seed, reducing the former into a coarse powder. The seeds are removed by sifting, and the husks by fanning. The powdered pulp is steamed by putting it in hempen bags on a bamboo lattice laid over caldrons of boiling water. The bags are then put in a wooden trough and firmly pressed by the insertion of wedges, an aperture at the bottom allowing the wax to escape. A little oil added to the mass facilitates this process. The bags are steamed again, and re-pressed.

The wax is greenish, and more like tallow than bees'-wax, being softer and more brittle than the latter substance. It melts at 105° F. It is purified by boiling with a lye till fluid, when it is run into a vessel of cold water, where it floats. It is bleached in the sun for a fortnight, boiled in pure water, run off into cold water, and bleached again. It is then in the form of a clear white powder of an almost crystalline formation.

The berries yield from 15 to 20 per cent of wax. At five years old a tree yields four pounds of berries; at eight years old, six pounds; at ten years, eighteen pounds; at twelve years, forty pounds; and at fifteen years, sixty pounds. After the eighteenth year the produce decreases.[1] The market value in London is £3, 2s. 6d. a hundredweight. It is used for manufacturing candles and vestas.

The Yama-urushi or wild lacquer-tree also yields wax. The fruit is collected early in autumn, and steamed without pounding. The melted wax is poured into a wooden tank with a hole close to the bottom, through which the wax flows into a large tub of cold water placed below, where it is rapidly stirred. It is then put in shallow boxes and dried in the sun for a fortnight.

Koga wax is made from another Japanese tree called by Meyer *Cinnamomum pedunculatum.* The Koga-tree is an evergreen which grows in Ossugori and the northern parts of Nagato. It flowers at midsummer, and ripens its fruit in autumn, when it is picked, soaked in water for four or five days, and trodden out with the feet to get rid of the outer rind. The quantity of vegetable oil in Koga wax fits it only for use in temperate countries, as it is very soft. Candles made from it burn brilliantly. The wax is said to be very cheap.[2]

[1] Spon, Encyclopædia of Industrial Arts.
[2] See Pharmaceutical Journal, 1874.

THE LACQUER-TREE (*Rhus vernicifera*).

This tree is said also to yield vegetable wax. It is a native of Japan, growing as far north as lat. 38°; and yields the celebrated Japanese lacquer. The trees are not incised till the summer when they are three years old. A horizontal gash is made in the bark, in the middle of which an incision is made. The juice exudes clear and milky, and is collected on a spatula and put into a vessel. By exposure it soon darkens. It is placed in tubs, and becomes thick and viscous, the thicker portion sinks to the bottom, from which the thinner portion at the surface is decanted. Both are strained, and are then of a rich brown colour, a thin coating of which gives a transparent yellow varnish. The black lacquer is made by stirring this in the open air for a day or two, which deepens the colour. An infusion of galls and iron, or highly ferruginous water, is added, and the whole is stirred and exposed till the water of the infusion employed has evaporated. The product is a jet-black varnish. The articles to be lacquered receive many coats of this varnish, between each of which applications the surface is ground and smoothed. The last coating is polished by being hand-rubbed.[1]

The tree attains a height of twenty feet. It grows freely in Australia and the greater part of the United States.

[1] Encyclopædia Britannica.

OIL-PLANTS.

CAMELINA SATIVA (*False Flax*, *Gold of Pleasure*).

Nat. Ord. BRASSICACEÆ.

A PLANT belonging to South and Central Europe, not uncommon in England, and naturalised about Auckland, New Zealand, and in the United States. It is a hardy annual, which grows to a height of two feet, with a branching stem, and slightly serrated lanceolate leaves. The seeds are small, and contained in pear-shaped pods. They yield by pressure a clear yellow-coloured oil, of peculiar mild flavour and smell. From its hardy nature it is widely distributed over Europe and Asia. It grows rapidly, and is cultivated as a second crop in Holland, Germany, and the north of France. It grows freely on poor sandy soil, but does better on richer land.

Fourteen pounds of seed is sown to the acre, either broadcast or in drills, usually after a corn crop. About three months after sowing, the pods begin to turn yellow, when the plant is cut or pulled. If left too long uncut, it will resow itself, and become a weed in time. When harvested, it is tied in sheaves and threshed, the yield being about thirty bushels of seed per acre, which gives 540 pounds of oil.[1] The oil is used for dressing cloth, painting, soap-making, burning, lubrication, and occasionally for cooking purposes. The marc is rather too

[1] Encyclopædia of the Industrial Arts, also Von Mueller.

acrid for feeding cattle, but the boiled seeds are very fattening. The chaff is used for feeding horses.

The fibre of the stems, separated like flax, is used for making sacking, sail-cloth, and brooms. The stems are a durable thatch. The seeds are said to allay pain, and are used for poultices in cutaneous affections. It is a decidedly useful plant, which, owing to its quick growth, may be used to replace other crops which have failed. It is rather a beneficial crop than otherwise, not exhausting the soil, and allowing the land time to recover after other crops. The seeds yield 28 per cent of oil.

In 1882 France had 30,360 hectares under poppies, rape, and Camelina, the produce being 421,981 hectolitres.

CASTOR-OIL PLANT (*Ricinus communis*).

Nat. Ord. EUPHORBIACEÆ.

Originally a native of South Asia or Africa, this plant has spread over most of the tropical and subtropical zones. It may be grown as an annual in England, where it is even said to have ripened its seed under very favourable conditions. It grows well in almost any part of Southern Europe, especially in Italy, where it is a regular crop; in Japan and China as far north as Shanghai. In the United States it grows as far north as New Jersey, but is not much cultivated beyond Illinois, Missouri, and California. In the southern hemisphere it is common in Peru, Chili, South Africa, Australia, and the north island of New Zealand, where it grows without cultivation about Auckland.

From its hardy nature, the castor-oil plant (fig. 19) is easily acclimatised in any country where the mean annual temperature is over 56°, especially in insular climates where it is not liable to be killed by frost in winter, and consequently becomes per-

ennial. But it must be remembered that this plant is naturally a tropical one, and in temperate climates cannot be expected to attain the same size or to produce as many seeds as it would where the heat is strong and constant: consequently in cool climates it is merely a herbaceous plant with

Fig. 19.—Flowering branch of the Castor-oil plant (*Ricinus communis*), with details of the male and female flowers, &c. The filament (*a*) is branched, each branch having a lobe of the anther; *b* Female flower; *c* and *d* Ovary entire, and in transverse section.

a soft stem, bearing seeds which yield a mild oil; but in warm countries the stem is ligneous and strong, the plant grows to a height of over eighteen feet, and the oil is powerful and drastic. It may be mentioned here that it is not desirable to

let the height of the plant exceed ten feet, as it then becomes more difficult to gather the seed.

A sandy loam is the best soil for this plant—clay does not suit it. There are several varieties of the castor-oil plant, of which the *Ricinus spectabilis* is said to be the most valuable.[1] These varieties may be divided into the large-seeded and small-seeded, the latter yielding most oil of a superior quality, the oil from the large-seeded varieties being unfit for use in medicine, and generally used for purposes of illumination, &c. The cultivation is simple.

In Illinois the soil is prepared as if for maize, laid off seven feet apart each way. The seeds are soaked for from twelve to twenty-four hours in warm water, and two seeds are put into each hole and sown like maize. April is the planting month. When the plants are three inches high, the land is ploughed, the plough going first close to the plants so as to put some fresh earth round them, after which the middle of each row is cleaned by either the plough or cultivator. When the plants are eight or ten inches high, thin them so as to leave one plant to each hill. When from a foot to eighteen inches high, the plants can take care of themselves if the weeds are kept from the middle space between the rows. The seed ripens in August. Sixteen to twenty bushels per acre is a fair crop, though in California and Texas thirty to fifty bushels are usual, the bushel weighing forty-six pounds. Where the climate is warm, the plants must be farther apart, as they grow larger.

The seeds are gathered when they turn from a reddish colour to a green brown, a cart being driven between the rows with the pickers in it, who select the ripe seed. This is done every other day. The seeds are thinly spread on a barbecue or level piece of beaten ground, and frequently turned. When the husks burst, they often "pop" away. When well dried, they are fanned. The seeds are shelled and pressed in hemp bags by hydraulic presses, the pressure being gradually applied.

[1] Encyclopædia of the Industrial Arts.

The shelling, crushing, and pressing must be performed as quickly as possible, for exposure to the air discolours the oil at this stage. When the oil is expressed it is heated with water in tinned vessels until the water boils and the albumen and gum separate as a scum, which is removed. The oil is filtered through Canton flannel and put in canisters. One bushel of beans yields five to six quarts of oil.[1]

In California the beans are subjected to a dry heat in a furnace for an hour to soften them. They are then put in a screw-press, which may be worked by horse-power, and will express eighty to a hundred gallons of oil a-day. From the press the oil is taken to a boiler, where sixty gallons of oil and the same quantity of water are boiled for one hour, and kept standing till next morning, when the water is drawn off and the oil put in sixty-gallon zinc clarifiers, where it stands eight hours in the sun, and is then taken out and canned for market. One hundred pounds weight of beans yields five gallons of oil.[2]

In India the seeds are treated thus: They are first sifted and cleaned from all extraneous matter, and while quite fresh are slightly crushed between two rollers. Husks and coloured beans are picked out by hand. The beans, put in gunny-bags, are then pressed in moulds into the shape of bricks. These bricks are placed alternately with sheet-iron plates in a press, and the oil is run into tinned pans. To one gallon of oil is added a pint of water, and the whole is boiled till the water has evaporated, when the mass ceases to bubble, and the pan is removed from the fire. The mucilage in boiling subsides to the bottom of the pan, and the albumen solidifies and forms a white layer between the oil and the water. The oil is then filtered through blankets and put up for export as cold-drawn oil. It is generally of a pale-straw or greenish colour. Cleaned seeds thus treated yield from 47 to 50 per cent of oil.

[1] Pharmaceutical Journal, 1877.

[2] Ibid., 1871.

1400 pounds of Calcutta seed gave the following result:—

1st quality oil,	. .	324 lb.
2d "	. .	87½ "
3d "	. .	76½ "

Or a total of 488 pounds of oil from 980 pounds of kernels.

1400 pounds of Madras seed yielded—

1st quality oil,	. .	318 lb.
2d "	. .	88 "
3d "	. .	74 "

Or 480 pounds of oil produced at a cost of 6d. a quart or 4d. a pound.

A good oil is produced by boiling the seeds in water for two hours, then drying them in the sun for three days; after which they are shelled, pounded, and boiled in water till the whole of the oil has risen to the surface. Three and a half pounds of seed treated thus yield one pound of oil of a straw colour, and free from unpleasant odour and flavour.[1]

The natives of Ceylon and India, and the negroes in the West Indies, obtain their oil in the following simple way: The seeds are freed from the husks, bruised in a mortar, tied up in a bag, and put in a pot of boiling water till the oil is boiled out of the seeds, when it is skimmed off, strained, and bottled for use. This oil is usually of a dark colour and viscid nature, highly drastic, but very irritating, and is better fitted for lubrication, illumination, &c., than as a medicine.

In Algeria about eleven and a half hundredweights of beans are the return from one acre, the beans yielding 52 per cent of oil. The yield of oil from castor-seed varies considerably, but good seed properly treated should yield from 50 to 60 per cent of oil. The value of East India castor-oil is from threepence to fourpence a pound. About Naples the plant grows to ten or fifteen feet high, and is generally biennial, sometimes triennial; the seeds ripen in autumn, and are smaller than East

[1] Spon, Encyclopædia of the Industrial Arts.

Indian. The seed is pressed very slowly, the pressure lasting several days. More oil is said to be got by pressing in warm weather, and the seed is therefore kept till the following summer. The press is lined with filtering paper, and the oil is filtered a second time after it comes from the press. Exposure to the sun is avoided, as it is said to produce rancidity. In England the oil is exposed in glass bottles to the sun for weeks to bleach it. Most of the Italian-grown seed is produced in the province of Verona.

The uses of castor-oil in medicine are too well known to require any notice. Two seeds grated and eaten are equal to one ounce of oil. In Italy the following emulsion is prepared under the name of "olio di ricini à l' Inglese":[1] One ounce castor-oil, one ounce syrup, quarter ounce powdered gum, well mixed in a dry mortar, stirring in one direction; when sticky, a little peppermint or orange-flower water and four ounces distilled water are added.

The other uses of castor-oil are: (1.) In soap-making—soap made from it being clear and free from smell. (2.) In dressing leather, principally morocco. As a dressing for leather of all kinds, especially boots, harness, &c., castor-oil is unsurpassed. It makes the hardest leather soft and pliable, and in the case of boots, does not hinder the leather from taking a high polish. (3.) Lubrication. (4.) Illumination—the streets of Lima being lighted with castor-oil. It is largely employed for the same purpose in India. (5.) In India and Algeria its leaves are used for feeding silk-worms. (6.) The fibres of the stems, treated like hemp, are textile material of some value.

The following varieties of the castor-oil plant are mentioned by Simmonds in 'Tropical Agriculture':—

Ricinus communis. The common castor-oil plant.
R. inermis, Jacq. India.
R. viridis, Willd. India.
R. lividus, Jacq. Cape.

[1] Pharmaceutical Journal, 1865.

R. integrifolius, Willd. Mauritius.
R. speciosus, Willd. Java.
R. apelta, Lour. (*Rottlera Cantoniensis*). China.
R. mappa, Lin. (*Mappa Moluccana*). Amboyna.
R. tanarius, Linn. (*Mappa tanaria*). Amboyna.
R. armatus or *communis*, Andrew. Malta.
R. dioicus, Forst. (*Mappe tanensis*). Islands of South Seas.
R. tunisensis, Despont. Algeria.
R. sanguineus. Red stem, young leaves and fruit red.
R. Borboniensis.
R. giganteus.

GROUND-NUT, PEA, EARTH, or MONKEY NUT
(*Arachis hypogæa*).

Nat. Ord. LEGUMINOSÆ.

Probably a native of the West Indies and Western Africa, but acclimatised in many parts of the world. Is an object of extensive cultivation in the United States, where it grows as far north as lat. 38°, being cultivated in Virginia and California, and the States farther to the south. It grows in Spain, the south of France, China, India, Brazil, and extensively in Africa. Originally a native of the tropics, it requires hot summers to ripen it to perfection; but it can be successfully grown in subtropical countries where the mean temperature of the summer months is 75° F.

The ground-nut is a straggling annual, with a hairy stem about two feet in length, spreading branches, and yellow flowers. It requires deep rich soil of a grey colour, as red or dark soils discolour the nuts. Calcareous soil suits it best. The formation of the nut is curious. After the flower withers, the stalk of the ovary bends downwards till the ovary is buried in the ground; the ovary then begins to expand, and a pod

about an inch long is formed, containing one or two seeds of an irregular ovoid shape, which ripen underground.

In America the land intended for this crop is ploughed about the end of March, harrowed, and marked off by furrows three feet apart. In May the seeds are dropped into these furrows, two at a time, with eighteen inches between each pair. They are covered with an inch and a half of soil. After ten days the plants begin to show. The land is kept clean by light ploughings, or by a hoe, till the plants nearly cover the space between the furrows, when a mould-board plough is run down the middle of these spaces, care being taken not to cover the plants. The crop is harvested at the first frosts in October, the plants being dug up with three-pronged forks. They are allowed to dry for two days, when they are stacked and thatched, or carted direct to the barn. In a fortnight the nuts are picked from the plants by hand, or by a machine for the purpose. The pods are cleaned in a fanning-mill—the nuts sometimes being further cleaned in a revolving cylinder, and bleached by the fumes of sulphur.[1]

In a good year the crop is a hundred bushels an acre. It is a most profitable crop; few are more so.

In Africa the cultivation is simple. The ground is prepared by burning off all vegetable growth, and being dug a few inches deep. The seeds are dropped into the soil and covered with an inch and a half of earth in October. The first seeds are ready in April; these are usually eaten green, as they are not thoroughly ripe till July.[2]

The seeds contain 42 to 50 per cent of oil. They are usually cleaned, decorticated, winnowed, crushed, and pressed by cold pressure, one bushel of seed yielding a gallon of the finest oil. The cake is then ground finely, heated, and pressed again, by which an inferior oil is extracted. The finest oil is clear, of a pale-straw colour; and so much does it resemble olive-oil, that large quantities are sold as the latter oil in Europe.

[1] American Encyclopædia.

[2] Pharmaceutical Journal, 1880.

When fresh the oil is little inferior to olive, but it is apt to get rancid with age. The oil is used for burning, and said to be an excellent lamp-oil. It is employed for dressing cloth and lubricating delicate machinery, such as watches. Large quantities go to soap manufactories, where the inferior oil is principally consumed.

After the oil has been expressed the cake remains. This is a valuable food for cattle, being particularly rich in flesh-formers, of sweet taste and agreeable flavour. Mr Tuson gives the composition of ground-nut cake as follows:[1]—

		Decorticated ground-nut cake.	Undecorticated ground-nut cake.	Decorticated linseed cake.
Moisture,		9.58	9.28	11.72
Fat and heat formers,	Oil,	7.40	6.99	12.09
	Starch and digestible fibre	27.63	23.67	25.29
Flesh-formers, Albuminoids,		42.81	32.81	32.64
Indigestible fibre,		7.87	23.80	11.79
Ash,		4.71	3.45	6.47

The stems of the plants are given to cattle, so the whole plant is of value.

Parched ground-nuts are commonly sold in the streets of Sydney and other Australasian towns. Children consume them largely. In the United States they are called pea-nuts, and are one of the principal edibles sold at the street-stalls. When fresh the taste is rich and delicate, and superior to most nuts, resembling excessively rich walnut. The seeds, roasted and bruised in a mortar and made into cakes, are said to be an excellent substitute for cocoa. When the seeds are parched and beaten with sugar they make an excellent sweetmeat.

Ground-nuts would be a profitable crop in Australia. Most of the nuts now consumed there come from the South Sea Islands.

[1] Pharmaceutical Journal, 1876.

MADIA SATIVA.

Nat. Ord. COMPOSITÆ.

A native of Chili and California, nearly allied to the sunflower. It is an annual plant of erect habit, with a hairy viscous stem. It is cultivated for the seeds, which yield from 30 to 40 per cent of a transparent yellowish oil, the finest qualities of which are fit for table use, being without odour, and pleasantly flavoured. It makes an excellent lubricant, and burns well.

The plant is hardy, and stands a considerable degree of frost. It grows well in Algeria and parts of Asia Minor, but does not prove very successful in the south of France. Considerable experiments were made with it in Wurtemberg, at first with good results; but later trials are said to have shown irregular returns. The climate of Chili is very dry, the mean temperature of January at Valparaiso being 66°, and that of July 57°.4: this gives us an idea of the climate required by this plant. It would do well in Victoria, and other of the more temperate parts of Australia, in all probability; though, from the fact of its growing well in Algeria, we may take it for granted that it would be a valuable plant even as far north as Brisbane. It should do well at the Cape of Good Hope.

The seed may be sown in drills two feet apart, with intervals of a foot between the plants in the rows, the cultivation being similar to that for turnips. The crop is cut as soon as the seeds begin to turn grey. It is necessary that the seeds be threshed out soon after cutting, as the stems ferment very easily owing to their viscous nature. The return of seed from an acre is about five and a half to six hundredweights, or about 240 pounds of oil. It is a more profitable oil crop than rape. Madia grows best on a sandy soil, and attains a height of from three to five feet.

OLIVE (*Olea Europea*).

Nat. Ord. OLEACEÆ.

The olive was one of the first trees brought under cultivation by man, probably in antediluvian times. Frequent mention is made of it in classical literature, and at the present day it is of as much importance to the inhabitants of Mediterranean countries as it was to their ancestors. Pliny says it was naturalised by the Romans in the time of Tarquin, 627 B.C.

Asia Minor appears to be the original home of the olive, but at very remote periods it was cultivated in Egypt and Greece, from whence it spread westward. It is one of the longest-lived trees known; De Candolle puts the average age at 700 years. Dr Davy saw trees at Paxo 300 years old which were still bearing fruit. An Italian saying is, "If you wish to leave your children a lasting inheritance, plant an olive-tree." The wild olive or oleaster (*O. sylvestris*) is now thought by French botanists to spring from seeds of the cultivated variety dropped by birds on waste land.

The olive is one of the most characteristic trees of the warm-temperate and subtropical zones, as it suffers alike from excess of heat or cold. Humboldt considered the mean annual temperature required for successful olive cultivation to range between 58° and 66°, the mean of the coldest month not being under 42°, nor that of the warmest less than 71°. In Europe the olive cannot be remuneratively cultivated beyond the 45th parallel of latitude. The countries where olives are grown comprise Portugal, Spain, the part of France adjoining the Gulf of Lions and the departments of Ardèche and Dôme, Italy as far north as Como, Sicily, the very south of Austria, Albania, Greece, Cyprus, the very south of the Crimea in sheltered localities, Turkey, Asia Minor, &c. In the United States the cultivation is successful in Georgia, Louisiana, Florida, and California. In the tropics the tree grows to a

great size, but bears no fruit; but as it fruits on those parts of the Mexican hills known as the *tierras templadas*, it might succeed when grown at a considerable elevation, and the experiment is being made on the Blue Mountains of Jamaica. South of the equator it promises to be a great industry in Chili, and in Australia south of Brisbane; and, from the occurrence of wild species of the family in New Zealand, it will probably become established in time in the warmer parts of the province of Auckland, where it has been introduced.

The olive can stand a considerable degree of frost if the cold sets in gradually, but sudden frosts are greatly to be dreaded. It has been noticed in France that highly manured trees in favourable situations suffer more from sudden frosts than trees not so highly cultivated growing in exposed places. When the trunk of a tree has been killed by frost, it should be cut back as soon as possible; the stump will throw out suckers, the best of which may be grafted in eighteen months' time. If the trees have only suffered slightly, they should be highly manured, and left unpruned for a year till they have recovered their strength and foliage. Snow is generally less dreaded than a dry frost.

The best situation for an olive-yard is on the slope of a hill facing the morning sun, beyond the influence of fog or mist, and sheltered from high winds. Few plants would grow where the olive thrives, wet marshy land being alone hurtful to it. It succeeds best on deep rich soil of average consistence, especially if the formation is limestone. It grows on poor stony land, but the produce is small, though the oil is of good quality. On marl or clay it bears badly, and lives but a short time. The climatic requirements of the olive are thus described by a French poet:—

> "En des climats glacés, sous un ciel nébuleux,
> L'olivier tromperait vos travaux et vos vœux;
> Il craint les aquilons, il cherche une contrée.
> Des regards du soleil en tout temps éclairée."

The varieties of the olive are difficult to describe, as almost

every place where the tree is grown has its local names. The following varieties are favourite ones in France for preserving purposes: Amandier or Gros noir; Verdale, Verdaou, or Pourridale; Saurin, Picholine, or Coliasse; Redounan, Redoutale, or Poumaou; De Lucques, Oliverole, Olivier odorant; Olivier d'Espagne, Plant de Fontvielle. For oil, the best known are: De Grasse, Cayane, or Caillet; Figanière or Caillet rouge; Caillet blanc; Entrecasteux, or Rougette; Raymet; Courniau, Plant de salon or Courgniale; Olivière; and the Olivier à gros fruits and Olivier à fruits rond of Algeria.

In Sicily the broad-leaved variety (*O. latifolia*) is most grown. It attains a greater size and bears more fruit than the narrow-leaved varieties of Tuscany and France; but the flavour of the fruit is inferior, and it is better suited for oil than for preserving.

Propagation.—Few plants can be more easily increased.

Cuttings one foot long may be taken from branches from a half inch to two inches diameter, a heel of old wood being left at the thicker end, and all twigs removed. These should be placed in well-manured and deeply trenched beds, one foot apart, burying about ten inches of their length in the soil; in dry weather water them when necessary. Allow all buds on the cutting to develop, select the largest, and tie it to the part of the cutting above it, and suppress the other shoots and buds. In a year the shoot will be self-supporting, when the end of the cutting may be cut off a little above it, and the wound coated with grafting wax. These cuttings are afterwards removed to beds where they have more room to develop, and they are there trained into the desired form.

Truncheons are very stout cuttings, from one to ten feet long, and from one to six inches in diameter. They are planted perpendicularly in spring, the holes being two to four feet deep, and should rest on well-decayed manure; like all cuttings they require water in dry weather. This is the quickest way to obtain olive plants with good straight stems. Another plan is to cut the truncheon into pieces one to three feet long; these are planted horizontally in the nursery or the

field at four or five inches below the surface of the soil, which must be well broken up. In two years plants from five to six feet high will be obtained. They must be cut clean without jagged edges.

Cuttings are also obtained by selecting a branch six to nine feet long. Prepare a well-manured bed for it one foot deep, on which it is laid horizontally, covering the thickest parts of the branch with nine inches of manured earth, the thinner with four inches, and the twigs with two inches, leaving the extremities of the branches to project three inches above ground. Water when required. Roots develop quickly; when rooted the parts are divided and planted separately in the nursery, receiving the same treatment as ordinary cuttings.

Young branches ten to sixteen inches in length, growing from knobs on trunks, may be taken off with an inch or so of bark from the parent stem, and planted in the nursery like ordinary cuttings.

Roots may be cut into pieces six inches long and planted with the top level with the ground; in two years they will be ready to transplant.

Uovoli.—In Italy embryonic buds which cause knobs on the stems of old trees are carefully removed with a sharp knife, coated with cow-dung, and planted a few inches apart in the nursery, the buds being uppermost. These knobs vary in size from that of a nut to the size of an orange.

Layers from roots and suckers are also successful. Suckers growing from the collars of trees and from large roots have a little extra earth drawn round them. When rooted they are removed with as many roots as possible, and planted two and a half feet apart in the nursery.

Seeds of fully ripe fruit have the pulp removed by washing, as the oil adhering to them prevents germination; they are soaked in a lye of chalk and wood-ashes or powdered quick-lime, and again washed. It may be necessary to rub the seeds against a brick to remove the pulp. They grow quicker when the shells are broken without hurting the kernel, but this is

difficult to do. They are grown in October one or two inches deep, some dead leaves being scattered over them to prevent jnjury from frost. In a year seedlings should be seven inches high. They grow slowly, and it is generally seven years before they are ready to graft.

Cuttings, truncheons, and layers from good ungrafted trees do not require grafting, but those taken from grafted trees and seedlings must be grafted. Shield-grafting is most common, but the crown, flute, or cleft grafts are also employed.

The after-treatment of nursery plants is as follows: In the spring of the first year all superfluous buds are rubbed off, leaving only five or six at the top of the plant. The second spring any new buds on the stem are removed, and only those branches left which are required in forming the head of the tree; if these are at the desired height the plant is topped. Every year afterwards only those branches are taken off which spoil the symmetry of the tree. In five or six years the trees will be formed: they are then planted in their final resting-places, in holes from two to two and a half feet deep, and from two and a half to three feet in diameter. The rootlets are carefully covered with earth, which is well broken up and manured, the soil being firmly tramped down round the trees. The French plant out in February after the winter frosts, the Italians and Spaniards in November. The distance apart at which the trees are planted depends upon the size of the variety. When the trees are in rows, thirty-three feet may be left between the lines, and the space between the trees should correspond to their future height. There is no rule on the subject, trees being planted at from fifteen feet apart, according to fancy, nature of the soil, &c.

Pruning.—The tree must be kept within manageable size, light must be allowed to penetrate freely, and the trees should not be allowed to over-bear. The object of the pruner is to preserve only as much bearing-wood as will allow equal annual crops. The fruit is borne on the wood of the preceding year. In France the tree is trained into various shapes, such as

pyramids, spheres, fans, and hollow goblets. A clear stem is usually allowed for the first five or six feet of their height. All gormand branches, suckers, dead wood, and unhealthy branches are removed; but the symmetry of the tree must always be remembered, and the primary aim of the cultivator must be to have a good head on the young tree, and, having succeeded in getting one, to keep it in shape. Should it become necessary to remove large branches, the wound must be covered with grafting wax. By yearly prunings the tree is kept strong and healthy, and much more profitable to the owner than when pruned at irregular intervals. When trees are intended to be kept at twenty feet high, the head should spring from eight primary branches; by cutting these above a bud they can be trained into any shape.

Cultivation.—Drainage is necessary to prevent any accumulation of water, but the ground should be fresh. During very dry weather irrigation or watering is beneficial to a moderate extent. In Spain stones are sometimes laid over the ground where the roots extend, to keep the soil fresh and lessen the cost of cultivation. It is better not to cultivate catch-crops between the olives, as it only robs them of their nourishment, and the land allotted to olives should be allowed to grow nothing else.

After the crop has been gathered, the land round the trees should be tilled or ploughed to the depth of nine inches or a foot. In countries subject to frost, earth may be drawn round the trunk of the trees to protect them during winter. In midsummer the land is tilled a second time. Stiff land requires more cultivation than light land, and where the climate is dry little tillage is needed.

Manure.—The olive is a gross feeder, and but little comes amiss to it as manure, whether of animal or vegetable matter. Among the fertilisers employed are—hoofs and horns of cattle, night-soil, dung, compost-heaps, cinders, marl, bones, pigeon-dung, soot, sea-weed, gypsum, and the refuse of the olive and grape after pressing. Those manures which decompose slowly

are the best to use. The manures should be applied immediately after the crop has been gathered. It can be laid in a circular trench one foot deep, dug about five feet from the trunk of the tree, and running round it; or it may be laid round the tree at a similar distance, and dug into the ground with forks. The nature of the manure will show which way to apply it, bulky manures being better applied in trenches. It is a necessary operation which must not be overlooked, as it stimulates young trees to bear earlier than they otherwise would; old trees require manure every second year. Virgin land requires less manure than land which has been previously cultivated. Mulching has a good effect in hot climates.

The return from the olive-tree is naturally influenced a good deal by climate. In France the trees commence bearing at about ten years old, and reach their prime at forty. In Sicily they continue to improve till they are a hundred years old. Du Breuil says,[1] "The more favourable the climate is, the longer has one to wait for the maximum yield of the olive-tree." But in genial climates the produce will probably exceed that of colder lands where the tree has to struggle against the inclemencies of winter. Dr Bleasdale[2] states that in Australia an olive-truncheon bears frequently the second, and nearly always the third year. Mr Bernays[3] says that a return should be got in four or five years from planting, and from the sixth year the trees should begin to pay steadily.

In France the early varieties of olives ripen in November, the later ones in December. When the fruit is thoroughly ripe, a clear oil will exude on pressing it between the finger and thumb. If the fruit is left on the tree till completely ripe, the yield of oil is greater, but its flavour is thought to be not so delicate as that obtained from fruit pulled just before it is fully matured. By adopting the French custom of gathering olives when a veiy little short of complete ripeness, the flavour of the

1 Du Breuil, Les Vignobles.

2 Dr Bleasdale, Culture of the Olive and its Naturalisation. Melbourne.

3 Olive Culture, L. Bernays. Brisbane.

oil is superior, the ravages of birds and insects lessened, and the tree gets more time to regain its strength before the next blossoming season.[1]

Three qualities of oil are manufactured in France: 1. Virgin oil; 2. Common oil; 3. Oil from a second pressing.

The fruit should be hand-picked, for the old custom of knocking it off the trees with rods injures the trees. When the fruit is out of reach, the trunk of the tree may be gently shaken, and the olives caught in a sheet spread on the ground. The olives are then taken to a shed with a boarded floor, on which they are thinly spread, and occasionally turned with a wooden shovel to prevent fermentation. Here they lose a great part of their moisture, the pulp softens, and they become easier to crush. When enough fruit has been collected, it is crushed to a pulp under a revolving wheel of wood, iron, or stone. Sometimes the stones are crushed with the pulp, but some authorities think they spoil the quality of the oil. The wheel is turned by steam, horse, or human power, revolving in a trough in which the olives are laid. As fast as the fruit is crushed, it is shovelled into stone basins and put in mat or rush bags, and pressed in a screw-press, slowly and not too hard. This virgin oil is run into tanks of water, where it is allowed to stand for some time to free it from mucilage and any impurities. This is the finest olive-oil usually sold; but a still finer oil is obtained, in very small quantity, from the crushed olives before they have been pressed, which is used for watchmakers' purposes and other fine work.

The bags of crushed olives, which have been pressed once, are dipped in boiling water and re-pressed. This oil is run into another cistern for four or five hours, and then drawn off and sold as "common oil." The pressed contents of the bags are next crushed under another wheel revolving in a trough, passed on to a heavier wheel of similar construction and crushed again in running cold water which flows through three cisterns called "enfers," which are connected with each other.

[1] Du Breuil.

The marc is again put in boiling water, and when sufficiently heated, is pressed for the third time, and the last of the oil obtained. This oil is of inferior quality, and used only for soap-making and illumination, but not for table purposes.

For oil-making on a small scale, M. du Breuil recommends a portable mill made by M. de Fallois, which costs £20. The cost of a hydraulic oil plant, suitable for small cattle gear, would be about £240, packed and delivered free on board in London.

Preserving olives. The fruit is gathered before it is fully ripe, while still green. In France this is done in September, and only the finest fruit is taken. A lye of potash, or one of one part quicklime to six parts wood-ashes, is prepared, in which the fruit is soaked till the alkali has penetrated to the kernel—the whole being covered with a cloth to exclude air, and to keep them below the surface of the solution. When sufficiently soaked, which is easily known by opening some of them, they are placed in fresh water, which is changed twice a-day, till the bitter taste of the fruit and the flavour of the alkali have both disappeared. The fruit is then put in brine, prepared by mixing three and a half ounces salt with a quart of water in which fennel or other aromatic herbs have been steeped. The olives are now bottled, and are ready for use in about a fortnight.

An olive-tree may be calculated to yield one gallon of oil every year. Reynaud mentions a tree in Var, supposed to be 225 years old, which gave forty-two kilogrammes of oil one season. He calculates a tree of ten years old to give a yearly return worth 6d.; at twenty years old, worth 1s. 3d.; at thirty years, worth 2s. 1½d.; at fifty years, worth 3s. 2d.; and at 100 years, worth 8s. 4d.

The diseases of the olive are cancer of the root, or "moufle," the cure for which is to remove the small roots, and to cut the cancer out of the larger ones—and to purify the soil. "Noir" is a black fungus which attacks both olives and oranges, covering the leaves and branches with a black sooty

powder. The use of lime and water syringed over the tree is a remedy; powdering the tree with lime or carbolic powder, on a dewy morning, will also be efficacious. The stems of trees should be kept free from lichens and moss by rubbing them with a piece of coarse sacking.

Among insects which attack the olive are *Hyllerinus olea* (the *bostriche* of the French), a borer. *Coccus oleæ* (*Kermès rouge* or *Cochenille adonide*), which attacks the young boughs and leaves, and in time forms little brown scales and a sooty powder, may be destroyed by lime or lime and water. *Psylla oleæ* (*Psylle de l'olivier*), a hemipterous insect which destroys the flowers. *Tinea oleella* (*Teigne de l'olivier*), a caterpillar hatched in the leaves, eats the fruit, and makes it fall before it ripens. *Musca oleæ* (the olive-fly) lays its eggs in the young fruit, and is a most destructive insect.[1]

In 1882 France had 315,876 acres of olives, which produced 5,447,981 bushels of fruit and 354,543 cwt. of oil, but is a large importer of Italian oil besides. This crop yielded 18,016,680 kilogrammes of oil, worth, at 1.50 fr. the kilogramme, 27,128,186 fr.; the cake amounted to 38,465,618 kilogrammes, worth, at 0.05 fr. the kilogramme, 1,821,918 fr.

Italy in 1883 had 2,210,981 acres of olive-yards; 11,023,000 kilogrammes of olive-oil were imported, and 80,626,000 kilogrammes exported. In 1884, 9,345,000 kilogrammes were imported, and 53,877,000, worth £3,000,000, exported.

Spain exported 21,309,000 kilogrammes in 1884, and Portugal 323,200 gallons.

Greece is said to have 15,000,000 olive-trees, yielding 25,000,000 *ocques* of oil, worth £1,000,000. The trees are never tended or cultivated, and only fallen fruit gathered.

The extent of olive-yards in Spain is supposed to be 2,500,000 acres. The quantities of oil exported fluctuate in an extraordinary manner, the export of 1874 being 26,373,000 kilogrammes, while that for 1876 was only 4,992,000 kilogrammes.

[1] Du Breuil, Les Vignobles.

Cotton-seed oil is rapidly replacing olive-oil in all but name, much of the "olive" oil imported into the United States being the native cotton-seed oil, which has only made the voyage to Europe and back and changed its name![1]

In 1883 the United Kingdom imported 31,053 tuns of olive-oil, and in 1884 17,213 tuns; the exports of olive-oil for the same years being 4493 and 2211 tuns respectively.

RAPE or COLZA (*Brassica napus* or *B. campestris*).

Nat. Ord. CRUCIFERÆ.

Rape, or coleseed, is a hardy oil-plant which may be grown in almost any climate from England to India. The first variety is cultivated in England as fodder for sheep; the second species, *B. campestris*, is grown on the Continent for the seeds, which yield about 38 per cent of colza-oil, used for burning in lamps, as a lubricant, and in some manufactures. The cake, after the oil has been expressed, is a valuable manure, and is used for feeding cattle if its hot acrid taste is overcome by mixing a little molasses with the crushed cake, or by boiling it with one-third of bean-meal, and adding cut straw or hay. Mr Johnston[2] gives the composition of rape-cake as—

Water,	7.6
Ash,	9.85
Protein compounds,	30.66
Starch, &c.,	33.52
Fibre,	8.05
Oil,	10.25

Rape is a valuable green manure; rape-dust is a most effective top-dressing for cereal crops, especially in wet seasons, from five to six hundredweights being applied to the acre.

[1] Encyclopædia Americana.

[2] Elements of Agricultural Chemistry.

Rape grows best on rich land; if the soil is poor, manure must be supplied before the crop is sown. When grown for seed, the plants are raised in beds, and transplanted in autumn to rows two feet apart, with eighteen inches between the plants, where they are left till February, when a horse-hoe is passed down the rows, and a top-dressing of rape-dust or other manure is given, and the plants are earthed up by a mould-board plough. The seed is also sown in spring in drills, two feet distant, and the young plants thinned out to eighteen inches apart. The crop is reaped with sickles about the end of July, when the straw and seed-pods turn yellow. The cut plants are laid across the rows, and a week after the seed is threshed out over sail-cloth. Care must be taken not to shake the stems in handling them, or much seed will be lost. After storing, the seed must be turned to prevent heating. The yield of seed is from twenty to forty bushels per acre.

When used as fodder, the cultivation is much the same as for turnips—two pounds of seed being sown to the acre in May, sheep being turned in about the end of July. Rape is liable to attack from the larvæ of a butterfly.

In 1881, 2521 acres of colza in Denmark yielded 31,468 bushels; the crop for 1884 was 72,375 bushels, but the acreage is not given.

France, in 1882, had 114,554 hectares of colza, which yielded 11.10 hectolitres the hectare, or 1,271,668 hectolitres, which at the average price of 22.81 fr. = 29,014,331 fr. Colza-oil fetched 1.20 fr. the kilogramme, and the cake 0.18 fr.; a hectolitre of seed yielded 20.62 oil and 33.82 cake. In 1884, 283,924 acres in France were under colza, the return being given at 2,864,265 cwt.

The Belgian crop of 1880 was 375,240 bushels, an average of 22.4 bushels per acre.

The imports of rape into the United Kingdom of late years have been—

1882.	1883.	1884.
548,806	767,127	755,395 quarters.

SESAME, GINGELLY, TIL or BENNÉ (*Sesamum indicum*).

Nat. Ord. PEDALIACEÆ.

An annual plant, a native of India, cultivated on account of its seeds, which contain 50 per cent of a fixed oil which resembles almond-oil, and is used to adulterate it. It is a good table oil, and is largely employed in soap-making and perfumery. The seeds are used in oriental confectionery. In the United States a demulcent drink is made from the leaves, and given in cases of catarrh and diarrhœa.

Although a native of the tropics, sesame may be grown in the subtropical zone, where the summers are very hot. It does not succeed well in South France; in Italy it is sometimes cultivated as far north as Bologna (lat. 44° 30′). It grows in Malta and Greece, and to a limited extent at Gallipoli. At Adana, in Asia Minor, it forms a considerable export. In Japan it grows to 42° N. lat.

In tropical countries, where the rainfall is small, the land is generally irrigated before it is ploughed, or between two ploughings, the seed being sown broadcast and covered by a light ploughing. The crop ripens in three or four months' time, when it is cut, and put in heaps for a week. It is then exposed to the sun for three days, which opens the pods and liberates the seeds. These are washed frequently in cold water and bleached in the sun.

In the Southern United States sesame is attracting considerable attention as a regular crop. It is sown in spring in drills three feet apart, with one foot between the plants. The leaves fall before the pods swell. When the plants are cut they are bound in sheaves, and allowed to dry for a few days, receiving no damage from rain. After the pods are thoroughly dry they are shaken over a sheet. About twenty bushels of seed are got from an acre, which yields sixty-three gallons of oil by pressure. The seed is first pressed cold for the best oil, then soaked in cold water and pressed again for the second

quality, after which it is subjected to steam or hot water and pressed for the third quality. The marc, known in South India and Ceylon as "gingelly poonac," is excellent food for cattle, especially for working bullocks. The oil is prized by the Cingalese and Tamils for medicinal purposes.

The plant grows to two or three feet high, a sandy loam suiting it better than stiffer soil. In Madras a million acres are planted with sesame.

SUNFLOWER (*Helianthus annuus*).

Nat. Ord. COMPOSITÆ.

A tall annual plant, probably a native of Mexico, which has spread throughout the temperate, subtropical, and tropical zones from England to India and China.

The cultivation is easy. From four to six pounds of seed are required to sow an acre of land. In England the seeds are planted one inch deep and six inches apart, which gives 16,000 plants to the acre. When the plants are one foot high they are earthed up, and receive no further attention. In Russia the seed is sown in drills eighteen inches apart, the plants being afterwards thinned so as to leave them thirty inches apart in the rows, or 11,000 plants to the acre. The seed is sown in September, and gathered in February. A writer in the 'Pharmaceutical Journal' recommends sowing the seed when a crop of early potatoes receives their last hoeing. The sunflowers are planted one foot apart in the ridges, and the land thus gives a double crop.

The return of seed is from 8000 to 17,000 lb. per acre. The article in the 'Pharmaceutical Journal' (1871), alluded to above, mentions the return of an acre as sixteen hundred-weights of seed, from which 275 lb. of oil were expressed, or 15 per cent of the weight of the seed harvested, while the

marc represented 80 per cent. The seeds of the white-seeded variety contain 25 to 28 per cent of oil, and the seeds of the dark variety 16 to 26 per cent. On good land the crop of seed should be fifty bushels to the acre, and one bushel of seed should yield one gallon of oil. The return of seed is said to be much increased by topping the plants. The sunflower grows best in rich calcareous soil. Some writers assert that it hurts the land by exhausting all the potash in it. This can to a great extent be overcome by burning the stalks and spreading the ashes over the land. The stalks grown on one acre of land contain nearly a ton of potash. The analysis of the ash of the plant is :—

Potash,	47.687
Soda,	1.092
Lime,	9.851
Magnesia,	5.291
Alumina,	0.280
Ferric oxide,	0.170
Chlorine,	5.004
Sulphuric acid,	1.344
Phosphoric acid,	6.968
Silica,	0.687
Carbonic acid,	21.626
	100.000[1]

Old mortar is one of the best manures for the crop.

The oil is of great value, and is employed for table purposes, lamps, painting (especially for greens and blues). It makes excellent soap of great softness. It burns nearly as long as poppy-seed oil. As a drying oil it is nearly equal to linseed. It is an excellent lubricant. For table purposes it is equal to olive-oil. The seed, shelled and ground, makes very fine sweet flour for bread. The marc is superior to linseed-cake for fattening cattle and poultry. The seed, roasted and ground, is a substitute for coffee. The leaves are excellent fodder, either fresh or dry. The seeds make demulcent and soothing emulsions. No flowers yield more honey; they also give a

[1] Pharmaceutical Journal, 1876.

fine yellow dye. The pith may be used in surgery instead of moxa. The oil is used for cloth-dressing. The seed is a valuable food for poultry and game. By treating the stem like flax, a very fine fibre is produced, nearly as fine as silk. In fact, few economic plants are more valuable, few are more neglected in our colonies.

I cannot conclude this short notice better than condensing the advice given by Mr Stephens in 'The Book of the Farm' regarding sunflower cultivation. "It requires deep, mellow, rich soil." Sow in rows, but drills will not support the long stems. "Its culture may be precisely that of the turnip up to applying the manure, which should be ploughed in broadcast instead of in drills, at the rate of twenty tons to the acre. Before the land is harrowed, four hundredweights guano should be sown upon the surface, and then the land should be harrowed, both along and across the ridges, to make it fine." Ribs are then made along the ridges with a small ribbing plough, twenty-seven inches apart, into which the seeds should be sown by hand at the rate of seven or eight pounds to the acre. The ribs must be covered with a hand-rake, as the seeds are light and easily displaced. Thin the plants in each row till they are one foot apart. The space between the rows may be once gone over with the drill-grubber, but the ground between the plants must be cleaned with the hand-hoe.

"When the stems and discs of the sunflower become withered, and the seeds shining and dark-coloured, the plant is ready to be removed from the ground." It may either be pulled up by the roots or cut with a sickle. The discs are cut from the stems, and the seeds "rubbed out with any suitable instrument, such as the Americans use for rubbing out maize. Mr Lawson informs me that from thirty to forty bushels of seed per acre may be deemed a fair crop of sunflower. These will yield fifty gallons of oil. The refuse will make 1500 pounds of oilcake, and the stalks, burned into ash, will afford half a ton of potash." "They are," says Mr Lawson, "a most impoverishing crop, particularly the taller-growing sort, *Helianthus annuus*, from which

circumstance the dwarf species, *Helianthus indicus*, has been preferred by some cultivators in France, who assert that, as its dwarf habit of growth admits of a greater number of plants being grown on a given space, it is not so much inferior to the other in quantity of produce as, from its appearance, one would be led to expect."

FIBRES.

BROOM-CORN (*Sorghum dura*).

A native of India, much cultivated in the United States, especially in Connecticut, on the rich alluvial land on the banks of rivers. It requires rich soil and high cultivation, and is only considered a profitable crop when grown on a large scale.

The seed is sown in drills three feet apart. Whenever the corn appears, it is hoed. At each hoeing the earth is drawn round the plants, which are thinned out till they are about six inches apart. Some cultivators then run a double mould-board plough down the rows. The heads are bent down and the brushes or panicles are cut while the seed is just past the milky stage, or before it is fully ripe. The heads are taken to the barn, and sorted into bunches with fibre of equal length. The seed is combed off, and the bunches dried on shelves and packed. The brush fetches £40 to £60 a ton. The yield of an acre is about 800 pounds, or a ton from three acres, though it frequently takes four acres to give a ton. The seed is used for feeding cattle, and the stalks for litter.

COTTON (Genus *Gossypium*).

Nat. Ord. MALVACEÆ.

The genus Gossypium probably contains seven clearly distinct species, of which the two most cultivated are: (1) *G. herbaceum*, a native of India; (2) *G. barbadense*, supposed to be a native of the New World. This species presents two important varieties: the "sea island," or long-staple cotton, with a soft silky staple an inch and a half to an inch and three quarters long; and the "upland," or short-staple cotton, with a staple from an inch to an inch and a quarter in length.

The geographical limits of cotton cultivation are bounded on the north by the parallel of 37°, and on the south by latitude 37°. The cultivation of cotton is one of the staple industries of the United States, where the cotton-bush is extensively planted in North and South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Texas, Arkansas, and Tennessee. In Europe cotton is cultivated to a very limited extent in Spain and Italy. In Egypt the cultivation is very successful. Asiatic Turkey, Cyprus, Syria, and Persia are naturally well suited for cotton-producing countries. In India the cultivation is widely spread, and the production nearly equals that of the United States. In China it forms a considerable crop about Shanghai. It is a leading crop in parts of Japan. The cultivation suits many parts of Australia, especially Queensland, where it grows well. The cotton-producing parts of the United States have a mean summer temperature of from 79° to 82°, and a mean winter temperature of from 43° to 55°. Owing to the intense winter cold which sometimes occurs, the plant is an annual in the United States; but where the winters are mild, and free from severe frosts, the cotton-plant is perennial. From this we see that cotton may be successfully cultivated in countries where the summer heat is tropical in its intensity, as the winter cold does

not materially affect the yield of cotton, though it alters the duration of the plant. In Australia good samples of cotton have been grown on the river Murray, where the plant was perennial.

The cotton-plant thrives best on moist porous soils, but does not like clays or soils of a retentive nature. Beds of alluvial deposit, deep loams, and friable soils on a limestone formation, are most suitable. In the following sketch of the cultivation the American system will be followed, as it is the most successful, and therefore the best to adopt.

The deeper the land is broken up the better, as the cotton-plant has a long tap-root. Plough at least eight inches deep, as early in the year as possible, and bring the soil into a fine tilth. Any manure which is to be applied should be spread over the land and ploughed in at the first ploughing.

Cotton is planted in rows from three to seven feet apart, according to the nature of the land. Four feet is a usual distance to leave between the rows. The rows may be marked out by dragging a strong wooden beam, with teeth set at the desired distance, over the land. A sixteen-foot beam would thus mark five rows. Run a light plough up these markings, making furrows four inches and a half deep. The seed should be cleansed from the fibre adhering to it, by mixing one part wood-ashes to eight parts seed, and rubbing between the hands. Only use the best seed procurable. The seed is then soaked in a weak solution of cow-dung and water, and afterwards rolled in wood-ashes, lime, or guano. It is then ready for planting. The earlier in the year the seed is sown the better; in the United States it is planted between the middle of March and the 10th of April. If a drill is used, twenty acres can be sown in a day. Some prefer planting by hand, dibbling in the seed. There are machines for the purpose which save much labour. The seeds should be dropped, three or four together, at intervals of from a foot to two feet—the former distance being probably the most usual. It is covered with an inch of soil, or even three inches if the land is subject

to drought. Where a sowing-machine is not used, the seed is covered by light hoes.

Eight days after planting, the young plants begin to show. When they are about four inches high, they will require weeding. Run a light plough or cultivator up the rows; follow this with a gang of people with hoes, to clean the ground around the plants. If the weather is wet, all weeds lying on the surface of the ground should be picked up by hand and put in heaps at the ends of the rows, or they will only be transplanted by the cultivator or hoe. Weeding cannot be done too thoroughly; it is the cheapest way in the long-run. Burn the weeds during dry weather. A fortnight after the first weeding, clean and stir the ground again; pull up all spare plants from each clump, reserving only the strongest one. Plant fresh seed where all the seeds have failed. Draw a little soil round each plant. Continue this cultivation till the plants become interlocked in the rows, when they require no further care. The surface of the ground round the plants should, by the different hoeings, be raised from three to four inches above the surface of the space between the rows.

Picking usually begins about the 1st of August, and lasts for four months. Commence when the fleecy balls of cotton begin to show. The cotton is drawn from the dead hulls by inserting the thumb and two fingers in the chambers, care being taken to avoid mixing it with leaves and other impurities. Each picker has a bag fastened round the waist, in which is put the cotton gathered. When the bag is full he empties it into a basket. A good picker will gather twenty pounds of cotton in a day in a good field. At night the cotton is emptied on the floor of a clean and dry room. The cotton must be kept perfectly dry while the seed is in it, as a little water will discolour it and make it rot. All impurities should be carefully removed, and the cotton kept in heaps about five feet high, covered with cloths. If it shows the slightest signs of heating it must be turned and cooled, or the oil exuding from the seed will discolour the staple. After remaining in

the store for a month, the cotton should be ginned to separate it from the seeds. There are many forms of gin, and the planter must select the one he fancies. The cleaned cotton is pressed into bales, which are hooped with iron. When the pickings cease to pay, cattle are turned into the cotton-fields and soon destroy the plants. In the tropics, and those sub-tropical countries with mild winters, the cotton-plant is perennial, and requires pruning, which consists in removing all dead wood. This is done in winter. The land must be kept clean, and stirred by a light ploughing, and drawing fresh earth around the trees. Where plants die, fresh seed should be sown in their place.

Cotton is not an exhausting crop, especially when the seed is returned to the land as manure, but the strong sunlight and clean culture cause great decomposition of organic matter. "Peas in light soils, red clover in clays, or lucerne in deep, rich, well-drained lands, would supply essential parts of a rotation that would give a wealth of animal products and a nearly doubled yield of cotton, derived from animal manures, the green manuring of vegetable decomposition, and the saving of much of the serious waste of valuable humus in continuous clean culture."[1] The same authority recommends a compost-heap made of 750 lb. stable manure, 750 lb. green cotton-seed, 500 lb. acid phosphate or dissolved bones; build in alternate layers four inches thick, and sprinkle with the phosphate after moistening with water. Ferment it thoroughly. The cost of such a compost is inconsiderable. Guano and crushed bones are the best condensed manures. Dressings of lime, wood-ashes, and gypsum are also effective, the cotton-plant requiring both potash and lime. Probably the best way to maintain fertility is to keep half the farm in cotton and the other half in the usual farm crops, following a regular rotation of cropping.

The yield of cotton in the United States varies greatly. An acre may sometimes yield 400 lb., but the average crop is

[1] Report of the Department of Agriculture of the United States, 1876.

from 150 to 200 lb. The cost of production in the different States will be seen in the following table :[1]—

	Cost of production of upland cotton.	Value.
	Cents per lb.	Cents per lb.
North Carolina,	9.3	9.8
South Carolina,	9.4	9.7
Georgia,	9.3	9.8
Florida,	8.7	9.2
Alabama,	9.9	10.1
Missouri,	9.8	10.2
Louisiana,	9.7	10.2
Texas,	8.0	9.1
Arkansas,	9.0	9.9
Tennessee,	9.0	9.8

The cotton-plant in the United States is not without its enemies. The "cotton louse" attacks the young plants; "cut-worm" is also destructive. A preventive is an application of ashes, or ashes and lime, round the trees. The "cotton moth" attacks the leaves of the plants; "army worms" and "ball worms" are also destructive.

Before the cotton is ginned it may be reckoned to contain one-third clean cotton and two-thirds seed, though some writers state that for every pound of clean cotton there are three pounds of seed. This seed is coated with particles of fibre adhering to it. To clean it, it is passed through a machine, and then screened. The seed is then ready for oil-making, or may be used as it is for feeding cattle. For milch cows it is a most valuable food, increasing the yield and richness of the milk to a wonderful degree. When used for oil-making, the seed is decorticated and crushed; it is then heated to 180° F., after which it is pressed till the oil is exhausted. The seed yields from 15 to 18 per cent of oil, the yield being very variously given by different authorities. The oil is of a reddish-brown colour, and has an agreeable sweetish taste, and is well suited for table purposes. It is refined by being first heated with boiling water, and then heated with a weak

[1] Report of the Department of Agriculture of the United States, 1876.

solution of caustic potash or soda, the crude oil giving 80 to 85 per cent of refined oil. It is used for lubricating, lighting, and painting. Large quantities have been imported into Italy for adulterating olive-oil, which it greatly resembles, the mixed oil being very difficult to detect.

The cake, after pressure, is used for feeding cattle. Voelcker found the proportion of oil in thin decorticated cotton-cake to exceed that of the best linseed-cake, and therefore considers the former superior to the latter as a direct supplier of fat.[1] Seven samples of cotton-cake showed the following average :—

Water, ...	9.28
Oil, ...	16.05
Albuminous compounds, or flesh-forming matter,* .	41.25
Gum, mucilage, and digestible fibre (heat - producing substances), ...	16.45
Celluline (indigestible fibre), ...	8.92
Mineral matters (ash), ...	8.05
	100.00
* Containing nitrogen, ...	6.58

The manure of cattle fed on cotton-cake is more valuable than that of cattle fed on linseed-cake.

The cotton crop of the United States was, for

1883, . .	5,700,600 bales,	. . .	off 16,777,993 acres
1884, . .	5,667,000 "	. . .	" 17,424,866 "
1885, . .	6,500,000 "	(estimated)	" 18,000,000 "

In 1884, 185,227,053 bushels cotton-seed were sold at an average rate of fourteen and a half cents, the total realising $6,295,362. The price of seed varied from thirteen cents for Virginian to seventeen cents for Georgian, a bushel weighing forty-five to forty-six pounds. A bale of cotton weighs 400 pounds.

The exports of raw cotton from India were :—

1883, . .	6,170,173 cwt.
1884, . .	5,094,421 "
1885. . .	5,066,057 "

[1] Physiology at the Farm.

Besides which, the exports of manufactured cotton were valued at :—

	Cotton twist and yarn.	Cotton manufactured.
1883, . .	£1,874,464	£2,093,146
1884, . .	1,983,019	2,326,018
1885, . .	2,506,617	2,080,017

During the same years India imported :—

	Cotton twist and yarn.	Cotton manufactured.
1883, . .	£3,378,190	£21,431,872
1884, . .	3,465,943	21,642,388
1885, . .	3,360,420	21,197,414

Egypt exports raw cotton and imports manufactured as follows :—

	Exported.		Imported.
	Raw cotton.	Cotton-seed.	Manufactured cotton.
1883, . .	£7,776,854	£1,767,221	£1,911,854
1884, . .	8,580,989	1,525,104	1,664.718

The cotton trade of the United States shows :—

	Imported.		Exported.	
	1883.	1884.	1883.	1884.
Raw cotton, .	4,082,000 lb. $801,000	7,019,000 lb. $1,380,000	2,288,075,000 lb. $247,329,000	1,862,573,000 lb. $197,015,000
Cotton manufactures, .	$36,854,000	$29,075,000	$12,951.000	$11,885,000

In 1884, 1,738,441 acres were, in Madras, under cotton, and about 14,000,000 acres in all India, the crop being 7,165,419 hundredweights.

Lagos exported 415,254 pounds raw cotton in 1883, and 530,414 pounds in 1884.

In 1879 Mr Ellison calculated the world's consumption of cotton at 4,480,000,000 pounds.

The state of the cotton trade of the United Kingdom for the last three years is shown in the following table :—

	Imported.		Exported.	
	Raw cotton.		Cotton yarn.	Manufactures.
	Cwt.	£	£	£
1882,	15,929,564	46,654,570	12,864,711	62,931,494
1883,	15,485,121	45,042,296	13,509,732	62,936,025
1884,	15,617,582	44,485,889	13,813,c78	58,935,154

FLAX (*Linum usitatissimum*).

Nat. Ord. Linaceæ.

Is cultivated in most parts of the world from India to North Europe, and in Australia, the United States, and South Africa. It requires deep, loamy, rich soil, which must be clean and in good condition. Coast-land exposed to moist mild winds suits it admirably. The land must be well drained, and neither too strong nor too light; on stiff clay the fibre is too coarse, and on poor gravel-land the return is small. It is usually sown after a corn crop or after lea. The land is ploughed in autumn to allow frosts to pulverise it. In March it is grubbed, harrowed, and rolled, any weeds which appear being removed by hand.

The choice of seed is important, as the various kinds require slight modifications in the manner of sowing. The seed should never be more than one year old. Sowing takes place in April in England. Dutch seed is preferred for heavy land or after a

green crop. Riga seed suits light soils. The seed is either sown broadcast, or in drills eight or ten inches apart; it is usually put in the ground about the end of March.

The first weeding takes place when the flax-plants are about an inch high. This is a most important operation, and requires care, not only in eradicating the weeds, but in doing as little harm as possible to the young plants. When the plants are six inches high, weeding is no longer necessary.

The flax blossoms in June, and if very fine fibre is desired it should be pulled before the seeds are quite ripe. The following are the signs of ripeness: 1. On cutting one of the ripest capsules across, if the seeds have changed from the white milky appearance they first present, to a pretty firm consistence and greenish colour, they are ready to pull. 2. When the lower part of the stem begins to turn yellow, and the upper capsules begin to turn brown. When pulled too soon, the fibre is weak and tender; when pulled too late, it is coarse and of inferior quality. The stems are pulled by hand, a few of the tallest being grasped at the first handful, which allows the shorter ones to be pulled at the second handful. In this way the long and short stems are separated, and they must never be mixed, or they spoil the sample.

The seed-pods are then removed by "rippling," or drawing them through a ripple, or iron comb, consisting of teeth eighteen inches long, set upright upon a form. The teeth are half an inch apart above, and three-sixteenths of an inch apart where they are screwed into the form. Two men sit across the form opposite each other and draw handfuls through the comb alternately. The seed is caught on a sheet spread on the ground below the ripple. The plants must be rippled as soon as possible after being pulled. The rippled plants are then tied in bundles and taken to the place where they are to be steeped.

Retting is the separating of the fibrous from the woody part of the stem. This is done by steeping the bundles of flax in ponds. River-water is better than spring-water for the pur-

pose, as it is softer; water containing lime is injurious. The water must be pure and clean. The ponds should be four feet deep, and not too large. One fifty feet by nine will ret the produce of one acre of flax. The bundles are put in the water, roots downwards, in rows, and kept submerged by planks covered with turfs. A gentle current of water passing through the pond is advantageous, as it carries off impurities, yet does not hinder fermentation. From eleven to thirteen days' submersion is enough. The progress of the operation is tested from time to time by selecting some stalks of average fineness and twisting them in opposite directions, when, if sufficiently retted, the fibre separates easily from the pith. When removed from the ponds the flax bundles are set on end against each other to drain, and the same day spread over clean short grass in a thin layer for from three to five days, being turned with poles, or not, as the operator deems advisable, till it is perfectly dry. Retting may be performed in a few hours by steam on the systems of Schenk or Watt.

Dew-retting is employed in Russia, the flax being simply spread on the grass, exposed to the weather for a considerable time. A silky fibre is obtained thus, of a brownish colour.

The stems of the dry flax are bruised between fluted rollers and scutched by wooden blades inserted in a revolving wheel, the stems being passed through an opening in an iron partition, the object of the scutching being to free the fibre from adhering portions of stem, or "boon," as it is technically called. When the boon has been knocked out of half the length of the stem, the workman withdraws it and inserts the opposite end; he then passes the flax to the next man, who treats it similarly, and the work is then completed. Scutching machinery is generally driven by steam-power. For a full account of flax-dressing, see Spon's 'Encyclopædia of the Industrial Arts.'

The seed of the flax-plant is called linseed; it contains one of the most useful oils known, which enters into the composition of printers' ink, oil-varnishes, soft-soap, paint, floor-cloths,

&c. Before expression, the seed should be kept four months in a dry place; this increases the yield of oil. By cold expression 22 per cent of oil is obtained, but by heating the seed to 200° F., the yield will be increased to about 28 per cent. The marc is well known as most nourishing food for cattle. Johnston gives the composition of linseed and linseed-cake as follows:—

	Linseed.	Linseed-cake.
Water,	9.0	10
Protein compounds,	19.25	22
Starch, &c.,	34.0	39
Oil,	25.35	12
Husk,	8.0	9
Saline mineral matter,	5.0	8
	100.60	100

The composition of linseed consists of:[1]—

Oil,	11.3
Husk,	44.4
Woody fibre and starch,	1.5
Sugar, &c.,	10.6
Mucilage,	7.1
Soluble albumen (caseine),	15.1
Insoluble "	3.7
Fatty matter,	3.1
Loss,	3.2
	100.0

The composition of the ash is as follows:[2]—

Potash,	25.85
Soda,	0.71
Lime,	25.27
Magnesia,	0.22
Oxide of iron,	3.67
Phosphoric acid,	40.11

[1] Seller and Stephens, Physiology at the Farm.
[2] Ibid.

Sulphuric acid, ...	...
Sulphate of lime, ...	1.79
Chlorine, ...	trace
Chloride of sodium, . . .	1.55
Silica, ...	0.92
	100.00

Percentage of ash, 4.63.

India and Russia supply England with the greater part of the linseed required by the latter country—the imports of linseed into the United Kingdom being 1,795,883 quarters in 1884.

Flax may be also grown for its stems, which are sold to paper-makers for about £4 a ton; the seed being sold to oil-mills, or used for fattening cattle.

From the amount of labour required in the cultivation of flax, it may be questioned whether it would be advisable to cultivate it in a country where labour is dear, as it necessitates the employment of more labour than most crops, and it is absolutely necessary that proper attention is paid to it, or success will not be attained. "Flax is proverbially either the very best or the very worst crop a farmer can grow." Mr Stephens ('Book of the Farm') advises the farmer, after pulling and rippling the plants, to dry them in sheaves and sell to the flax-dresser, thus avoiding the risk of retting and preparation, as these operations require considerable technical skill.

An acre of flax yields from four to ten hundredweights of dry stems; one hundred pounds retted flax should give from forty-five to forty-eight pounds broken flax, and this should yield twenty-four pounds scutched flax, or about ten pounds of tow. Scutched flax is worth from £20 to £50 a ton.

It is needless here to enumerate the uses of flax in linen and other manufactures, the importance of these being well known.

PRODUCTION OF FLAX IN EUROPE.

	Seed.			Fibre in cwts.		
	1882.	1883.	1884.	1882.	1883.	1884.
Sweden, . bush.	210,591	172,044	...	...	...	...
Holland, . "	320,619	321,140	...	120,673	105,165	...
Belgium, . "	...	...	...	329,669	376,988	...
France, . cwt.	418,836	377,946	298,597	810,759	716,288	715,107
Italy,[1] . "	...	...	...	1,780,596	1,797,482	...
Hungary, . "	...	...	..	86,472[2]	104,810	108,080

In 1880, Belgium had 98,993 acres under flax, which yielded 50,049,173 lb., or 474.3 lb. per acre; in 1881, Russia had 3,776,288 acres; in 1883, Sweden had 27,922 acres under flax and hemp, and Italy 495,766 acres of both crops. In 1883, Holland cultivated 30,635 acres of flax; and in 1884, Hungary had 27,432 acres flax. In 1884, France devoted 110,014 acres to flax; in 1882, France had 133,740 acres under flax, which yielded 1152 lb. of seed per acre. In 1884, France imported 75,939,000 kilogrammes of flax, besides what was produced in the country.

Russia exported, in 1884, 399,996,000 lb. flax, and 60,048,000 lb. flax tow. Holland exported 29,654,820 lb. the same year, and Belgium 76,619,856 lb. In 1884, Italy exported 33,955,000 kilogrammes of flax and hemp, and England imported 1,339,811 cwt. of dressed and undressed flax. In 1880, Belgium had a crop of 50,049,173 lb., which gave an average return of 474.3 lb. per acre.

In the United States, flax is principally grown in the following States: Iowa, 2,700,000 bushels; Dacota, 2,882,788 bushels; Kansas, 1,315,130 bushels; Minnesota, 826,281 bushels; Nebraska, 382,747 bushels.

The French crop of 1882 amounted to 2,204,625 kilogrammes of oil, worth on an average 1 franc 12 cents the kilogramme, or a total of 2,463,801 francs; the linseed-cake

[1] Flax and hemp. [2] Total yield of flax.

amounted to 4.731,594 kilogrammmes, worth 0.21 francs the kilogramme, the total value being 981,877 francs.

In 1885 there were 2449 acres under flax in England, 41 in Scotland, and 108,149 in Ireland; in 1884, for the whole United Kingdom, 91,444 acres, of which 89,197 were in Ireland.

HEMP (*Cannabis sativa*).

Nat. Ord. CANNABINACEÆ.

An annual plant, growing to a height of six or eight feet, but on rich soil to eighteen feet. The stalk is hollow, and consists of a soft pith covered by cellular tissue, surrounded by a thin, rough, fibrous bark. The plants are diœcious, the male and female flowers being borne on different plants. The male plants differ from the female in being more slender and delicate, and rather taller; the fibre is finer, and the flowers grow in clusters of nine or ten, at the crown of the stem. The female plants have tufts of leaves at the extremity of the stem, the seed growing on the stem. The growth of the male plant is faster than that of the female.

Hemp is supposed to be a native of North India and Persia. Herodotus mentions it as growing near the Black Sea—which shows that it has been long naturalised in Europe, if not indigenous to the western parts. It grows in most parts of India, and on the Himalayas to an elevation of 10,000 feet, but succeeds better at 5000 or 6000 feet elevation. It is found in Japan, China, Persia, Egypt, and North Africa, Spain, Russia, Poland, and Italy—the last three countries producing the best fibre. It also grows in France, Holland, Sweden, and in England, principally in Yorkshire, Suffolk, Lincoln, and Somerset. In the United States it is a staple crop in Kentucky, Missouri, and Tennessee. It grows in Canada, Cape Colony, and Victoria.

A rich moist soil suits it best, especially beds of alluvial deposit. Stiff clay is bad. Poor light soil gives better fibre than rich land, but the return is small. It is a very exhausting crop, rich land in the south of Italy being impoverished after two or three consecutive crops of hemp, unless plentifully manured.

The land must be in good tilth and well prepared, being ploughed in autumn, and again in spring. About the end of April, when the soil begins to get warm, sow with three or four pecks of seed to the acre, in drills eighteen inches apart. The seed is harrowed in and rolled, and requires no further care, as it grows luxuriantly enough to prevent the growth of weeds. When the flowers of the male plants turn yellow and fall, the whole crop is cut or pulled. The leaves and tops of the male plants are removed before pulling, and the pulled stems tied in small bundles and retted. The female plants only have the leaves removed when they are pulled, as they are rippled for the seed. Some cultivators dry their hemp and sell it without retting, the purchaser retting it by steam.

The fibre of the male plants being better than that of the female plants, induces some cultivators to gather them separately, the male plants being pulled three months after sowing, as soon as they have shed their pollen, being distinguished from the female principally by their faded flowers, yellow leaves, and whitish stems. One month afterwards, the female flowers are faded, and they are then pulled. The plants give better fibre if pulled before the seeds are fully ripened; but if the seed is required for sowing it must be allowed to ripen thoroughly. When grown for fibre only, the whole crop may be pulled or cut while flowering — the leaves and flowers stripped and left on the ground for manure. In England, sixteen bushels of seed and from six to eight hundredweights of fibre is a good crop per acre.

The cultivation recommended by Mr Stephens[1] is to manure the land with twenty tons of dung to the acre. Cross-

[1] Book of the Farm.

plough the land in spring, and harrow it as for potatoes. As the young hemp-plants are easily hurt by frost, do not sow till the end of April. Sow in rows nine to fourteen inches apart, according to the capability of the land to produce a large or small plant. To secure a fibre of fine quality, set the plants close together, sowing two and a half to three bushels of seed to the acre. Birds must be frightened from the newly sown land, or they will do much mischief. While the plants are young, keep down weeds by the hand or horse-hoe, but take care not to injure the young plants, for they will not rise again if once broken.

Hemp is grown for seed alone in the United States, being cultivated like maize, in hills three and a half to four feet apart. Drop a dozen seeds in each hill, thinning them at the first hoeing to five or six plants. At the second hoeing reduce them to four. When the male plants can be distinguished remove them, leaving two or three female plants to each hill. One male plant being allowed to remain in alternate hills each way, or one male plant to every four hills, these are removed when the pollen is shed. The seed-bearing plants are cut before the seed falls of its own accord, stacked till dry, and beaten out. Winnow with care, and spread the seed in thin layers to prevent its sprouting. An average crop is from twelve to fifteen bushels an acre. More seed is produced by growing plants well apart than by growing them close together.[1]

Hemp is usually dried before being retted, but some cultivators prefer to steep it as soon after cutting as possible. Retting may be done by water, dew, or snow. The first of these ways is the most used in England. Ditches are cut close to the banks of a river, the bundles of hemp are laid at the bottom, and kept submerged by stones or weights till the fibre detaches easily when the thumb-nail is run up the stem; the stems require from ten to twenty days' steeping. A better plan is to arrange a series of basins, one below the other, so

[1] Johnson's Cyclopædia.

as to receive the water which flows from the first to the second, and the second to the third, and so on. These basins should be two feet deep. The plants are steeped in the lowest for two or three days, and then passed on to the one above, till they reach the upper basin, when the process is completed. As one basin is emptied, fresh hemp is put into it. Hemp steeped in stagnant water has softer fibre than hemp steeped in running water. Hemp intended for cordage requires little retting; but when it is to be used for fine purposes, it must be thoroughly well retted.

Dew-retting is usually done in January and February, the stems being stacked till wanted, and then spread out on grass. It requires about six weeks' exposure, the stems being frequently turned and watered if too dry. When pink spots appear on the stems, they are tied in bundles and put in stooks to dry. The whitish fibre is got by this method, but it requires considerable labour.

Snow-retting is adopted in Russia. The hemp is simply spread on the ground when the first snow falls, and allowed to remain covered by snow till spring.

After water-retting, the hemp is spread on grass and bleached for three weeks, being frequently turned during the operation, which is complete when the pink spots appear on the stems. When dry, it is once more tied in bundles and put in a barn. It is then broken by being passed between heavy iron rollers; and lastly scutched, when the fibre is cleaned and freed from woody matter adhering to it by wheels with five wooden blades attached to them. As these strike the flax passed towards them, they knock the "boon" or woody matter out of the fibre. The operation is performed twice, and the fibre is then ready for packing. In parts of Ireland and on the Continent, both hemp and flax are scutched by hand, being beaten with a heavy wooden beetle and heckled, the result being very fine fibre; but it is more expensive than machine-dressed.

Hemp-seed contains from 25 to 34 per cent of a fatty oil

somewhat resembling linseed-oil. It saponifies badly, and is used for making soft-soap, lighting, or painting. As a boiled oil the odour and colour are against its use. The marc, after expression, is used for cattle-food, being fattening but purgative.

In tropical countries the hemp-plant contains a resinous principle much used in oriental countries as a narcotic. *Bhang* or *siddhi* consists of the leaves and stalks dried. It is smoked with tobacco or alone, and produces an exciting delirium or intoxication. The resin of the plant is collected by men clad in leather aprons, who run through the hemp fields, the resin adhering to the aprons, from which it is scraped off. It is called *charas* or *churrus*. In small doses it produces excitement, appetite, pleasing illusions, and laughter, followed by stupor and sleep. Persons addicted to its use have a wild, startled look, and their eyes roll violently. The English preparations of hemp are used in asthma, whooping-cough, and neuralgia, to allay pain and produce sleep.

The production of hemp in the following countries was, in hundredweights :—

	1882.	1883.	1884.	Acreage in 1884.
Sweden,	56,306	51,308	...	...
France,	879,124	878,101	816,407	160,291
Hungary,	874,036	819,303	826,050	162,111
Italy,[1]	1,780,596	1,797,482	...	...

In 1881 Russia had 1,387,905 acres under hemp, and in 1884 exported 102,636,000 lb. and 5,076,000 lb. hemp yarn. In 1884 Germany exported 43,978,836 lb. The Italian exports of raw hemp the same year were valued at £1,000,000, and went principally to the United Kingdom and France. The United States imported raw hemp to the extent of 26,000 tons in 1884.

[1] Flax and hemp, the latter predominating in the proportion of five to one.

In France, hemp is mostly cultivated in the departments of Maine et Loire and Sarthe. In 1884 there were 282,744 acres under hemp in France and Corsica, 86,609 acres being cultivated for seed and the remainder for fibre. In 1882 France had 73,429 hectares (of 2.46 acres), which produced an average of 6.08 quintals (of 220.4 lb.) per hectare, the total crop of tow being 446,742 quintals, which, at an average price of 94.49 francs the quintal, was worth 42,212,394 francs. Hemp-seed was grown on 46,984 hectares, and gave an average return of 6.74 hectolitres, or a total of 470,065 hectolitres, worth, at 21.10 francs the hectolitre, 6,675,005 francs. Hemp-oil was worth 1.30 franc the kilogramme, and cake 0.20 franc.

Holland, in 1880, had a crop of 1,374,749 lb., which averaged 608 lb. per acre.

England imports a large quantity of hemp every year. In 1884, 353,985 cwt. tow of flax and hemp, and 1,347,253 cwt. of hemp and other like substances, were imported, against exports of 38,532 cwt. tow and 286,062 cwt. hemp, &c.

JUTE (*Corchorus*, sp.)

Nat. Ord. TILIACEÆ.

Jute is made from the fibre of two species of Corchorus—*C. capsularis* and *C. olitorius*. The difference between these plants is very slight, and is principally in the fruit—that of the first-named species being globular with a flattish top, while that of *C. olitorius* is nearly cylindrical, about the thickness of a quill, and two inches in length. Both are Asiatic plants, cultivated in India for the sake of the fibre of their stems. They are annual plants, and grow to the height of ten or twelve feet or more.

Jute requires a climate which is both warm and humid. It grows well in the deltas of the Nile, and flourishes on the

alluvial soils of Louisiana, Florida, South Carolina, and the warmest parts of the United States, requiring a similar climate to what is demanded by the cotton-plant. A sandy clay or alluvial soil suits it best. It will thrive where the soil is ferruginous or impregnated with salt, but does not succeed on light soils. A moist forcing climate is the chief desideratum in this cultivation. Alternate showers and sunshine assist the growth, but the young plants do not stand inundation, though after they are well started this does not hurt them; but the fibre of jute grown in water is inferior.

The land is broken up in autumn and well pulverised. In north Bengal the seed is sown in March or April; at Calcutta it is sometimes not sown till July. The seed is usually sown broadcast, but in some parts of India the custom is to transplant the seedlings. The plants come up in about a week, when they are thinned and weeded. Beyond one or two weedings, jute receives little tillage or attention.

In three or four months after sowing, the plant flowers, when it is cut, the fibre being then at its best. If the cutting is delayed, the fibre is coarse and woody, though strong; if cut before flowering, the fibre is weak. The plants are cut with a heavy socket-knife or sickle. After being cut, the plant is stacked for three or four days till the leaves fall off; it is then tied in bundles of one length and immersed in water for a period varying from four days to a month, and regulated by the age of the stems, the temperature, and the character of the water used.

Stagnant water sets the fibre soonest, but it is apt to discolour and weaken it. Running water takes some weeks, and gives a glossy white fibre of superior strength. The plants are kept submerged by turfs, stones, or heavy pieces of timber. Over-steeping discolours the fibre; under-steeping makes it difficult to clean. The stems are tested daily, and when the fibre separates easily the bundles are removed.

The inner bark is stripped off for the entire length of the stem, and washed by dashing it repeatedly on the surface of

the water, and drawing it back so as to wash off all woody matter and separate the fibres. When thoroughly washed it is immediately dried in the sun till the fibres readily part, when it is done up in hanks and is sent to market.

The leaves and ashes of the plant are used for manure, the stalks for making baskets and as fuel, the seed—which ripens a month after the plant flowers—is pressed for oil, and the cake given to cattle. The jute itself is used for making canvas, carpets, sacking, towellings, &c. The fibre, being fine and glossy, can be used for mixing with silk for hats, &c., and superior paper has been made from the refuse jute.

The yield of fibre from an acre of jute is from 1200 to 3000 lb. The cost of cultivation and preparation of an acre of jute in Bengal is 16s.

When the plant is allowed to seed, half a ton of seed can be got from an acre, the principal value of which is for the oil it contains.

The exports of raw jute from India were—in

	1883.	1884.	1885.
Cwt., . .	10,348,909	7,017,985	8,368,686
Value, . .	£5,846,926	£4,592,635	£4,661,368

The value of the Indian manufactures of jute, including gunnies, being—

1883.	1884.	1885.
£1,487,831	£1,334,231	£1,543,870

In 1884 there were twenty-one jute-mills in India, nineteen of which were near Calcutta, employing 47,868 hands.

In 1883, 7,385,028 cwt. jute were imported into the United Kingdom; and in 1884, 5,081,358 cwt. Exports for the same years were 1,864,442 cwt. and 1,662,867 cwt. respectively.

WHITE MULBERRY (*Morus alba*).

Nat. Ord. MORACEÆ.

The white mulberry, probably a native of China, appears to have been introduced into Europe about A.D. 552. The black mulberry was brought to Europe at an earlier period. It yields a pleasant fruit; but as the leaves are not such good food for silk-worms as those of the white species, we will confine our attention to the latter tree.

The white mulberry grows to a height of about thirty feet. The leaves are bright green in colour, heart-shaped, serrated, and thin. The flowers are monœcious, with long footstalks. The fruit is small, white or pale red, and insipid. The tree is less hardy than the black mulberry.

The white mulberry has a wide geographical range. The northern limit is about lat. 43° in America, 46° in Europe, and 40° in Eastern Asia—south of which it may be cultivated to the equator, the multicaule variety being indigenous to the Philippines.

In France the mulberry is grown at Macon (lat. 46° 19′ N.), but the cultivation of the mulberry and sericulture (rearing silk-worms) is carried on extensively from Lyons southwards. The temperature of the three months after the leaves have been gathered must not be below 53° F., to allow the shoots time to mature before winter, and there must be at all times plenty of light and fresh air. Frequent hoar-frost kills the tender shoots of the tree. Fogs, mists, and the effluvia from marshy places make the silk-worms unhealthy.[1]

There are many varieties of mulberry, and consequently considerable diversity of opinion exists as to which is the best sort to cultivate. The following are most employed:—

Multicaule.—Morus alba, var. *multicaulis*. A very early variety, which requires a warm climate. Leaves large and thin, containing a good deal of moisture. Requires good soil and shelter from high winds. A valuable variety, much grown in France and Italy.

[1] Du Breuil, Vignobles.

Rose.—Fruit pale violet, leaves large and thin, having a reddish appearance when young. Is a valuable variety, though it only yields half the weight of leaf which the multicaule does; yet the leaf keeps fresh longer than that of any other sort. Prefers a mild climate with little frost.

Hybrid.—Supposed to be a sub-variety of the multicaule, but it is much hardier and has stouter leaves, which keep fresh for a considerable time after picking.

Moretti.—A hardy purple-fruited variety. Leaves large and abundant, keeping fresh for a considerable time after picking, and yielding, for the weight of leaf, about as much silk as the multicaule.

Lhou.—Leaves large and rather thick, fruit reddish-black. Much valued in China.

Roman.—Fruit white, leaves large, thick, and glossy. Stands frost well.

When mulberry-leaves fail, silk-worms are fed in their earlier stages with young leaves of the elm, bramble, rose, barberry, dandelion, lettuce, paper mulberry (*Broussonetia papyrifera*), osage orange (*Maclura aurantiaca*), &c., the last-named being a valuable hedge-plant.

Propagation.—The mulberry is raised from seed, layers, or cuttings. Seedlings are hardy; they stand drought well, and are long-lived. Layers and cuttings suit the multicaule, hybrid, and Lhou varieties best, and are chiefly employed to get plants which are to be dwarfs or half-standards. Grafted plants yield more leaf and come to maturity sooner than ungrafted; but the latter afford fully more nourishing food for the worms, and give a silk of very good quality.

The fruit reserved for seed is taken from trees which have not had their leaves much picked. The fruit is soaked in water for two days, and the seeds are then washed out. Those which sink are selected and stratified in sand, and sown the following spring in beds, being lightly covered with earth. In a year the plants are from one to two feet high; they are then transplanted to other beds, and placed three feet apart. The following year they are cut down to about four inches above

the collar, and shield-grafted at the foot with a pushing bud. Should this not succeed, they are grafted later in the year with a dormant bud. All shoots which spring from below the graft are suppressed, and the graft itself tied to the part of the stem left above it for a support. Full standards are sometimes flute-grafted at five or six feet above the ground.

The young trees are allowed to throw out three primary branches, and from these secondary branches are trained, so as to give the head of the tree the shape of a goblet or cup.

Propagation by cuttings is slower than by seed. Wood a year old is chosen, cut into pieces eight inches long, and planted with two buds above ground. They are watered regularly. Another way is to cut a piece of wood into small pieces with a bud on each; these are planted horizontally in light earth, and frequently watered. If planted in spring they soon strike.

For layers, cut a young mulberry-stem through at seven inches above the soil; shoots soon form, and the following spring the stump is completely buried in a mound of earth. When the shoots take root they are separated from the stem.

The leaves of standards are more difficult to gather than those of smaller trees, and this is not done in France till they are six years old. Half-standards have stems three feet high, which facilitates gathering the leaves; and these smaller trees are better suited for steep land and arid places, but they are more liable to injury from frost. Dwarf trees begin to branch at from eight to eighteen inches above the collar; they are the most likely to suffer from frost, and the leaves are not so valuable as those of the two former styles, but they come sooner to maturity. The leaves of mulberries grown in hedges are gathered earliest. Standards are planted twenty to twenty-three feet apart; they give most leaf, and it is the best food for the worms, and leads to finer silk, but gathering is more expensive: they are planted in holes five feet in diameter and three feet deep. Half-standards are planted from seventeen to twenty feet apart in holes three feet in diameter and three feet deep. Dwarf trees are from nine to twelve feet apart, and hedge-plants twelve to eighteen inches.

In France,[1] gathering the leaves begins about the middle of April or early in May. The leaves are not gathered wet with either dew or rain. An ordinary double ladder, or one which runs on wheels, is required. The labourer runs his hand down each branch, stripping off the leaves, which he puts into a sack tied round his waist. When his sack is full, he empties it on a sheet; and when that is filled, it is tied by the four corners and taken to the *magnanerie*, or rearing-house; but the leaves must be always protected from the sun to prevent them withering. Each branch must be entirely stripped, because, if a few leaves are left, they are apt to absorb all the sap, and retard the production of new leaves. After the leaves have been gathered, the branches are cut back, leaving the two buds nearest their base, preserving enough of the branches to keep the tree goblet shape. All wounds in the tree should be coated with grafting-wax.

The regular pruning is performed in early spring. The aim of the pruner is to develop the growth of a certain number of long, vigorous, leafy boughs. At the same time, the head of the tree must be kept open and wide. Thin useless branches, and dead wood must be taken off. Some cultivators prefer to prune their trees so as to have one crop of leaves every two years.

The ground is tilled twice a-year between the trees, in spring and summer. The tree responds well to manure, but over-manuring the trees hurts the quality of the leaves.

In the south of France, full standard trees have shown the following results, the crop being picked yearly :—

At 3 years old,	. . .	7	lb. of leaves.
4 "	. . .	25	"
5 "	. . .	37¾	"
6 "	. . .	56¾	"
9 "	. . .	106	"
12 "	. . .	147½	"
21 "	. . .	218	"

When the leaves are picked every second year, full stand-

[1] The French system of sericulture has been followed in this article, from the works of MM. Du Breuil, Gobin, and others.

ards, on good soil, ought to give 220 lb. of leaves at nine or ten years of age, and double this quantity at twenty years. At forty-five or fifty the produce begins to fail, and at about seventy years old the trees are renewed by cutting back the branches, in the same way that fruit-trees are occasionally treated. Half-standards yield about three-fifths as much as full standards. Dwarf trees seven years old bear about forty-five or fifty pounds of leaf each tree. The value of leaf varies greatly, but it is generally worth about 2s. 3d. the hundred-weight in France.

REARING SILK-WORMS.

The *magnanerie*, or rearing-house, must have a bright, dry, airy situation, with nothing offensive in its neighbourhood. M. Robinet[1] gives the dimensions of a *magnanerie* of sufficient capacity to rear ten ounces of eggs as: length, forty-five feet; breadth, twenty-six feet six inches; height of the walls thirty feet, and to the ridge-pole forty-two feet six inches. The ground-floor is divided into four rooms: an air-chamber, 26 × 20, paved with tiles, and containing two stoves by which the temperature is regulated; a hatching-room, 20 × 13; a leaf-room, 26 × 17.6; and a passage. The pipes from the air-chamber should be conducted through the building. The height of the rooms is eleven feet. The upper storey is reserved for rearing the worms; it contains three rows of frames, which support the trays for the worms. These frames contain double rows of trays, and are separated by four passages, each one yard wide, so as to allow easy access to each tray. The trays are set on shelves arranged in tiers, one above the other, with twenty inches between each tier, right up to the top of the walls. These trays are four feet four inches square, and made of wood, or the framework only is wood and the bottom wire-gauze or canvas. The whole building must be thoroughly ventilated and lighted, and well supplied with thermometers, as success depends on keeping the temperature even.

[1] A. Gobin, Muriers et vers à soie.

The newly hatched worms require the most tender leaves, which should be as fresh as possible. The leaf is never picked during the heat of the day, as it would soon wither. If the leaves begin to dry, they are sprinkled with water to keep them fresh. When first brought in, the leaf is spread on the floor without crushing it, and turned from time to time with a wooden fork to keep it from heating. Twigs, fruit, and foreign substances are picked out of it. The leaf should be chopped before being given to the worms during the first three stages of their growth; this may be done by knife, or in a little machine like a chaff-cutter. The worms are allowed to eat as much as possible; the refuse of the leaf, which the worms leave, is given to sheep or cattle. The strictest cleanliness is necessary in every part of the house. In removing litter, &c., from the worms, a net, with meshes of rather less than an inch, made of hemp or cotton-thread, is used; these are the same size as the trays. Two workpeople take the net by the four corners and lay it gently on the table over the worms; a few fresh leaves are placed on it; the worms climb through the meshes and attack the fresh leaf; the net is then gently raised, and the worms are laid on the adjoining tray, which is kept empty; the old net, tray, and litter are then removed. The greatest care must be taken to keep all the worms on each tray at the same period of their existence, or great confusion will occur.

At Paris, silk-worm eggs hatch spontaneously when they have received 1100° to 1200° Cent., spread over 106 to 120 days. Eggs may be kept in tightly corked glass jars till required for hatching. Every fortnight the jars are opened, the cards of eggs removed, and laid on a linen cloth to dry; the jars are wiped out, the eggs are replaced in an hour's time, and again corked up. The jars are kept in a very cool cellar. Avoid exposing them to sudden changes of temperature. They will keep in an ice-house. From a week to ten days before the mulberries burst into leaf, take the eggs out of the cellar, and lay the cards on trays in the hatching-room, pinning a

piece of fine washed muslin over each card. The temperature of the hatching-room, when incubation begins, must be 64° F., the hygrometer being kept at 75° Cent. by watering the floor. The following day the temperature is raised to 66° F., and raised 2° every day thereafter till the sixth day, from which it is kept at 77° F. till the eggs are hatched; the hygrometer being raised to 80° by placing basins of water round the room. In eight or ten days the eggs hatch. The young worms are attracted to the top of the muslin by laying little pieces of chopped mulberry-leaf upon it, when they are conveyed to the trays. About two days after the first worms appear the hatching is most general. The worms of the same age are all placed together. One ounce of eggs produces about 40,000 worms. The life of the larva is divided into five stages.[1]

First Stage.—Begins at hatching, and lasts about five days. On the fourth day they sleep, and are cleaned by having the net changed a little before. On the fifth day they change their skins. The other days they are hungry, and must be fed every two hours, day and night. In this stage, the worms hatched from an ounce of eggs will eat from four and a quarter to eight and a half pounds of leaf daily, and only cover two and a half square metres of tray. The temperature of the house is kept at 74° F.

Second Stage.—The worms now cover five square metres of tray. The duration of this stage is four days. They are cleaned on the third morning, sleep that night, and shed their skins on the fourth day. During this stage they will require to be fed as before every two hours, but require more leaf. When the worms show signs of sleep, a net is spread over the tray, and the active or backward worms are induced to come on some fresh leaf; these backward worms are separated and kept together. The temperature of the house is now kept at 72° F.

Third Stage.—The worms now require twelve square metres of space on the trays. The stage lasts six days. They now receive leaf not so finely cut as formerly, and are fed every

[1] The instructions given by M. Gobin have principally been followed.

two hours, and will eat about one hundredweight of leaf in this stage. They are cleaned on the fourth day, sleep on the fifth, and shed their skins the sixth. During these six days the backward worms should be removed twice, and put with others in the same stage. The temperature is kept at 70°.

Fourth Stage.—The worms will require twenty square metres of tray-room. They are fed every three hours. The temperature is now and henceforward kept at 68° F. The leaf is now given to the worms whole, and they will eat about three hundredweight of leaves. They are cleaned on the third and fifth mornings. They go to sleep on the fifth evening, and cast their skins on the sixth day.

Fifth Stage.—The worms require about thirty square metres of space at the beginning, and fifty at the close of this epoch of their existence. They are fed every three hours. This stage lasts for eight or nine days, during which they will eat from fifteen to eighteen hundredweight of leaves. The worms now become yellow, transparent, and soft. They are cleaned three times. They now show a desire to climb. They sleep on the eighth day.

It is necessary to explain the arrangements now required for the worms. Brooms, twenty to twenty-four inches long and six inches thick, are made of heath, birch, rape, and many other plants. These are tied with string so as to leave the head branching, and arranged round the sides of the trays—the branching end of the first being on the tray, and the branching end of the next in the air, and so on—a sort of hedge being also made in the middle in the same way. There is an invention of M. le Chevalier Delprino which replaces these brooms. Care is taken to make the places suitable, for if the worms do not find what they require, they will form cocoons without spinning.

The period during which the worms climb lasts about two days, but the cocoons are not gathered for eight or ten days after. The workpeople then take the brooms and detach the cocoons, which they deposit in baskets, the weight of which is

known. These baskets contain separately the cocoons of the best sort, double cocoons, and those that are dirty or damaged. When the baskets are filled, the produce is weighed.

The covering of the cocoon is torn off by taking hold of it at the side, an operation requiring considerable skill. The passive insect in the cocoons is killed thus: A cask of white wood, with the bottom pierced with holes, is filled with baskets of cocoons; the top, also perforated, is put on, and the cask, which is about forty inches long by two feet in diameter, is set over a water boiler of nearly the same size. After the steam has penetrated through the holes into the cask for twenty minutes, the cask is removed, the cocoons are spread out to dry on shelves, and turned frequently. They are kept covered to keep them from dust. By thus killing the worms the cocoons lose 65 per cent of their weight.

The brooms on which the animals spin are cleansed by passing them through a clear flame of fire. The trays and all nets, &c., are washed with hot water and soda.

Some of the best cocoons are kept for eggs. These hatch in about twenty days, or less. The cocoons are fixed on sheets of paper with flour-paste and laid on trays in the hatching-room, the temperature of which is about 70° or 72° F. The cocoons should be half male and half female; the latter are more oval in shape and fuller, those of the male being thinner and slightly contracted in the middle. When hatched, a male and female moth are placed together on a cloth raised at one end, and so arranged that it hangs in a slightly sloping direction. The moths are moved about an hour after they are hatched, by lifting them by their wings. The male and female are left together for from ten to twelve hours. After the impregnation of the females the males are fastened in a corner of the cloths, doubled and secured with a pin. When the female has laid her eggs she is similarly confined in another corner. The eggs are smaller and round, and covered with a mucilaginous substance, which makes them adhere to the surface upon which they rest. The female generally begins to

lay as soon as the male has left her. About 75 per cent of the eggs are laid then, the greater part of the remainder the following day, and the balance the third day. The female lays from 300 to 700 eggs in all: when this is finished she dies. The male moth dies after his part in the work of reproduction is over. Sometimes the female is made to lay on sheets of paper instead of linen. The eggs are weighed by the ounce, a French ounce (thirty-one grammes twenty-five milligrammes) containing 42,187 eggs.

The sheets of eggs are hung over strings, in a chamber where the temperature does not exceed 59° F., the side of the cloth on which the eggs are being doubled inwards. If desired, the eggs may be detached from the cloths by soaking them in water warmed to 58° F.; the cloths are then stretched, and the eggs removed by gently scraping them off with a knife. The eggs are then dried and put in card-boxes. After the eggs are laid, if they are placed in an ice-house for forty days, they will hatch in autumn instead of the following spring. If the cocoons are kept in a cellar where the temperature does not exceed 50° to 54° F., the hatching will be retarded.

M. Gobin calculates the expenses of rearing ten ounces of eggs to be—

	Francs.	Cents.
Cost of ten ounces of seed, at 8 francs, . . .	80	0
Value of growing leaf, 12,000 kilogrammes, at 6 francs the 100 kilogrammes, . . .	720	0
Salary of manager, 30 days, at 4 francs, . .	120	0
120 days' work of women, at 1 franc 25 cents, .	150	0
Heating, cost of fuel, ...	160	0
Lighting, ...	15	0
Branches for the spinning, ...	17	50
Rent and insurance of establishment, . .	250	0
Gathering the leaf, at 2 francs the 100 kilogrammes,	240	0
Cleaning the leaf, at 1 franc the 100 kilogrammes, .	120	0
	Fr. 1872	50

Or, in English money, £75. This makes the cost of rearing each ounce £7, 10s.

The profits of the rearing would be—

	Francs.	Cents.
Value of litter (equal to cost of heating), . .	160	0
Cocoons, 500 kilogrammes, at 5 francs 50 cents the kilogramme, ...	2750	0
	Fr. 2910	0
Less expenses, . .	1872	50
Net profit, . . .	Fr. 1037	50

Showing a total profit of about £43, 5s.

The industry is one which is very well adapted for families who wish to increase their incomes by a few weeks of light and interesting work, which may be easily performed by women and children. As it is the general custom in Australia for the daughters of small settlers to stay at home rather than go out to service, sericulture offers employment for girls of this class which would enable them to add a considerable sum to the family income.

In 1884 there were 141,477 *sericulteurs* in France; 281,104 ounces of silk-worms' eggs were hatched, which gave an average return per ounce of 22.2 kilogrammes cocoons; the value of a kilogramme of yellow cocoons was 3 francs 78 centimes, and of green cocoons, 3 francs 58 centimes. A return of twenty-five kilogrammes of cocoons from the ounce (of twenty-five grammes) of eggs is considered necessary to defray the expenses of rearing, and in Drôme and other parts of France the industry is no longer remunerative, chiefly owing to the attacks of "muscadine," a fungus. The value of an ounce of eggs in 1884 was 13 francs 50 centimes. In 1882, 248,603 ounces of eggs were hatched, which produced 9,721,206 kilogrammes of cocoons, worth 3 francs 85 centimes per kilogramme, the total value being 37,441,682 francs.

Hungary produces silk of fine quality, the production being in

1882,	24,445	kilogrammes cocoons,	or 12.41	kilogrammes to the ounce.
1883,	72,142	" "	or 17.24	" "
1884,	122,133	" "	or 18.95	" "

In 1881	Austria	produced	1,577,452	kilogrammes	cocoons.
" 1882	"	"	1,807,393	"	"
" 1883	Salonica	"	490,400	"	"
" 1882	Adrianople	"	200,000	"	"
" 1883	"	"	300,000	"	"
" 1882	Asia Minor	"	10,000	"	"
" "	Crete	"	24,000	"	"
" "	Cyprus	"	27,000	"	"
" "	Damascus	"	48,718	"	"
" "	Japan	"	27,800	"	"
" "	Bengal	" about	6,768,500	"	" [1]

The annual production of raw silk in Italy averages for the last fifteen years, 3,000,000 kilogrammes.[2]

IMPORTS OF SILK.

	1883.		1884.	
	Raw Silk.	Manufactured.	Raw Silk.	Manufactured.
France, ...	*K. 11,785,000	..	K. 11,199,000	..
"	£ 12,248,840	£1,725,520	£ 10,743,400	£1,703,160
Italy, ...	K. 874,000	..	K. 987,000	..
"	£ 1,468,160	830,200	£ 1,578,400	831,640
Spain, ...	K. 192,972	..	K. 180,000	..
"	£ 347,680	374,600	£ 314,280	373,080
Portugal, . .	£215,550		£201.600	
Switzerland, . .	lb. 5,927,460	..	lb. 6,211,480	..
Belgium, . .	K. 130,952	..	K. 207,604	..
"	£ 366,680	427,280	£ 581,280	395,000
Holland, . . .	..	69,500	..	49,916
Germany, . .	K. 3,423,000	..	K. 3,783,700	..
"	£ 6,576,000	..	£ 6,963,750	..
Hamburg, . .	..	874,050	..	919,200
Denmark, . .	..	lb. 307,820	..	lb. 317,755
Sweden, . . .	..	£173,300	..	£169,700
Russia, . . .	lb. 972,000	..	lb. 972,000	..
"	£ 1,689,575	350,866	£ 1,580,325	355,616
Austro-Hungary, .	lb. 3,138,300	..	lb. 3,054,480	..
" .	£ 1,538,000	1,258,415	£ 1,478,083	1,225,500
Egypt, . . .	..	145,822	..	117,343
United States, .	lb. 3,253,000	..	lb. 3,223,000	..
" . .	£ 2,925,625	7,659,166	£ 2,600,208	7,640,416
India, . . .	lb. 2,386,150	..	lb. 2,210,893	..
"	£ 1,074,156	977,768	£ 969,575	1,201,348
Canada, . . .	..	439,581	..	451,186
United Kingdom, .	lb. 10,422,194 †	..	lb. 12,377,417 †	..
" .	£ 3,778,827	10,523,920	£ 4,587,723	10,984,073

* Kilogrammes marked K. † Includes knubs, waste, thrown and raw silk.

[1] From a French report on the industry.

[2] Mr Kennedy's report.

Exports of Silk.

	1883.		1884.	
	Raw Silk.	Manufactured.	Raw Silk.	Manufactured.
Germany,	..	£8,016,600	..	£8,547,200
Holland,	K. 131	..	K. 11,000	..
"	£ 131	..	£ 10,916	..
France,	K. 5,077,000	..	K. 5,716,090	..
"	£ 5,881,040	12,048,900	£ 6,209,200	9,472,880
Switzerland,	lb. 3,862,760	lb. 5,149,980	lb. 4,271,740	lb. 4,898,740[1]
Spain,	K. 56,767	..	K. 45,592	..
"	£ 102,000	..	£ 69,362	..
Italy,	K. 7,910,700[2]	..	K. 7,705,900[2]	..
"	£ 11,655,760	£537,000	£ 11,122,640	£699,200
Austro-Hungary,	lb. 2,964,940		lb. 2,737,680	
"	£1,252,666		£1,006,093	
China,	lb. 12,818,266[3]	..	lb. 14,054,800[3]	..
"	£ 5,376,175	1,306,500	£ 5,110,145	1,361,495
Japan,[4]	lb. 4,413,992[5]	..	lb. 3,114,958[5]	..
"	£ 3,406,458	..	£ 2,345,833	..
India,	lb. 1,523,345	..	lb. 1,733,187	..
"	£ 596,838	306,928	£ 671,555	315,375
United Kingdom,	416,395	340,805	299,113	644,722

1 Ribbons.
2 Includes cocoons, raw, thrown, and waste.
3 Includes raw, thrown, refuse, wild, and cocoons.
4 Japan exported silk-worms' eggs to the value of £8541 in 1884.
5 Includes cocoons (value £41,458 and £52,708).

DRUGS.

ANISE (*Pimpinella anisum*).

Nat. Ord. UMBELLIFERÆ.

THIS annual plant, a native of Egypt and the Levant, is cultivated in Italy, Malta, Spain, and France. In England it is sometimes grown for seasoning purposes. It grows also in India, Persia, North Africa, &c. The fruit is reticulate, about the size of a pin's head, with an aromatic taste and strong pleasant smell. It is known as aniseed, and is much used in oriental cooking and confectionery. It is also used in making liqueurs and in medicine, being a carminative, and given for colics and flatulence; the powerful smell makes it useful in disguising the taste of other medicines.

It is sown in drills a foot apart, with a few inches between the plants, on light well-tilled ground, which must be kept clean and free from weeds. The plants, sown in spring, ripen towards the end of summer, when they will be rather over a foot in height.

Oil of anise, the principal product of this plant, has the following composition:—

Carbon, ...	81.08
Hydrogen, ...	8.11
Oxygen, ...	10.81

It is obtained by distilling the fruit with water, and retains

the smell and taste of the fruit. It is worth 6s. 10d. a pound in London.

Spirit of anise, employed in medicine as a stimulant—stomachic and carminative — is prepared by dissolving oil of anise in proof spirit. With the addition of sugar, it forms a liqueur known as *crême d'anise.*

Anise-water is prepared by mixing one fluid ounce of the oil with a half-gallon of water. Given to children for flatulent colic.

Star-anise is the fruit of *Illicium anisatum*, a plant growing in the extreme south of China. The oil of star-anise is worth 8s. 6d. per pound in the London wholesale drug-market. China star aniseed, in January 1886, is quoted at from £4, 5s. to £4, 10s. a hundredweight in the London market.

ASAFŒTIDA (*Narthex asafœtida*).

Nat. Ord. UMBELLIFERÆ.

A plant belonging to Thibet, Afghanistan, and Persia, which, along with other allied plants, yields the drug under consideration.

The *N. asafœtida* (fig. 20) grows on sandy soil, and attains a height of five or six feet. At four years old it is ready for cutting. About May the stems are cut off close to the root, round which the soil has been previously dug and pulverised. The milky sap which exudes from the wound solidifies on exposure. When the quantity of sap diminishes, a fresh slice is taken from the surface of the root, and the juice then obtained is thicker, and coagulates better than that obtained at the first cutting. As the sap solidifies, it is scraped off, any sap which overflows being subsequently obtained from the dug earth surrounding the root. While the sap is exuding, the root is protected from the sun to keep it from withering. Fresh

incisions are made as long as the sap continues to flow. The produce is at first of a bright white colour, but darkens to a yellowish brown as it dries. The yield of asafœtida varies according to the size of the root, from one ounce to two pounds being obtained from a single plant. The present London price is—

Good to fine,	40s. to 60s. per cwt.	
Middling, .	30s. to 35s.	"
Ordinary, .	12s. to 20s.	"

Fig. 20.—The Asafœtida plant. *a* Root, with the crown cut off, to allow the gum to exude; *b* Crown, with root-leaves; *c* Flowering stem.

A superior gum-resin is obtained by incising the leaf-bud above the root. It is of a reddish-brown colour when hardened, and fetches a higher price in the Afghan market.

Though asafœtida is used in France and other countries as a condiment, in England, owing to the disgusting smell it possesses, it is only used as a drug, and even then to no considerable extent. As a drug it is used in cases of flatulence, hysteria, chronic catarrh, and convulsions. The inner part of the fresh stem is considered a luxury in Persia, and used as a vegetable.

Asafœtida is also obtained from *Scorodosma fœtida*, an umbelliferous plant belonging to the steppes of the Caspian. The resin of both plants, when subjected to aqueous distillation, yields a volatile oil.[1]

CAMPHOR

Is found in greater or less quantities in a number of plants and trees, especially the Lauraceæ and Labiatæ. Thyme,

[1] See Johnston's Chemistry of Common Life.

lavender, rosemary, sassafras, &c., yield it in small quantities, but it is chiefly obtained from three sources :—

1. *Camphora officinarum* (*Cinnamomum camphora*), the well-known camphor laurel of Japan and China.

2. *Dryobalanops aromatica*, or *D. camphora*, from which is obtained camphor-oil, and Borneo or Sumatra camphor.

3. *Blumea balsamifera*, one of the Compositæ, growing in South China and Eastern Asia.

The two last-named being tropical plants, are beyond the scope of the present work, but an interesting account of them will be found in Spon's 'Encyclopædia of the Industrial Arts.'

Fig. 21.—*Camphora officinarum*—The Camphor Laurel or Camphor-tree.

Camphora officinarum (fig. 21), a species of laurel, native of China, Formosa, and Japan, where it grows to a height of fifty feet. The wood is white, with a strong odour of camphor, and much used to preserve articles of clothing against insect attacks; but there are many imitations of it made by scenting ordinary wood with camphor-oil.

Camphor is principally found in Formosa (lat. 25° N.), in Fokien (lat. 24° to 28° N.), Chusan (lat. 30° N.) In Japan the tree is widely distributed; "the camphor is found in most parts of the country, particularly in some of the higher regions."[1] The southern and south-western provinces seem to suit it best, south of lat. 36°. The camphor laurel has also been acclimatised in Madeira, the West Indies, Cape Colony, and parts of

[1] Encyclopædia Britannica—article "Japan."

Italy and South Europe. Sir Ferdinand von Mueller says, "It endures the Port Phillip frosts, but the leaves suffer." It grows well around Sydney, where the cultivation might be turned to some account. It is occasionally seen in gardens about Auckland.

It seems to grow best under the influence of mild sea-air, where the climate is moist and forcing. It is hardy, and the production might doubtless be greatly increased by planting the tree in our Australasian colonies, and on the hills of Jamaica and Ceylon.

The extraction of camphor is performed thus: The wood of the stem and branches is cut into chips, which are put into stills with water. The head of the still is filled with straw or twigs, on which the camphor carried over by the stream of the water is deposited and solidifies. When a sufficient quantity of this crude camphor has been collected, it is put into thin flint glass flasks and heated in sand-baths, the camphor being exceedingly inflammable, as is the vapour given off by the camphor. These are heated to 250° to 370° for half an hour to expel the water remaining in the mass. The temperature is then raised to 400° F., and kept at this point for twenty-four hours. When the camphor has melted, a stopper of paper is put in the neck of the flask to partially close it. Sufficient heat is retained to cause the camphor to sublime on the upper part of the flask in a thick crust, but the heat must not be sufficiently strong to remelt it. The flasks are covered with glass shades to exclude air, which would render it opaque instead of translucent. When all the camphor is sublimed, and only the impurities left at the bottom of the flask, the flask is removed; cold water sprinkled upon it shivers it, and the cake of pure camphor removed. The whole operation of refining occupies two days, and requires great skill and care.

In Japan a rude still is constructed with an iron bottom, over which is a perforated sheet of metal. The camphor-chips are then put in with a considerable amount of water, sufficient to saturate the chips. Heat is applied, and the camphor is

carried by a bamboo pipe into an inverted wooden box, resting, with its open side downwards, in a tray of water, and a jet of water running over it; here the camphor is condensed. The water with the chips is kept steadily at the boiling-point. Every day the still is cleaned and recharged, and the camphor removed from the receiver-box. The camphor is then subjected to easy pressure, by which twenty-five per cent of oil is extracted. Camphor thus prepared has to be sublimed on arrival in Europe.

The wood of the laurel yields more camphor when it is very full of sap. The camphor lodges in the knots and interstices of the fibres and in the pith.

Pure camphor is white, semi-transparent, and slightly unctuous; the taste is slightly bitter and acrid. It is very volatile and inflammable. In medicine it is warm, stimulating, and calmative, useful in flatulence, nervous affections, cramps, coughs, low fevers, spasmodic diseases, and diarrhœa. For internal use it is frequently given in the form known as camphor-julep, which consists of camphor, two drams; spirits of wine, forty minims, rubbed together in a mortar; to which add carbonate of magnesia, four drams; then add, gradually, water, two pints. Filter through paper. Dose, half an ounce to two ounces every three hours for fevers, nervousness, and hysteria. Spirits of camphor is made by dissolving five ounces camphor in two pints spirits of wine.

Camphor is much employed in perfumery, is an ingredient in China ink, and used for keeping insects away from clothing, &c. It is largely employed in preserving objects of natural history from insect attacks. Its use as a protection against infectious diseases is now believed to be imaginary.

For further particulars, see "Camphor," Spon's 'Encyclopædia of the Industrial Arts.'

The London quotations for camphor were, in January 1886, China, 75s. to 77s. 6d.; Japan, 80s. the hundredweight.

CARAWAY (*Carum carui*).

Nat. Ord. UMBELLIFERÆ.

Grows in the temperate and warm-temperate parts of Europe and Asia. Is grown in Essex and other parts of England as a crop. Is a biennial plant (fig. 22), cultivated for its aromatic, spicy seeds, which are used in confectionery, medicine, &c. In medicine, the essential oil is obtained by aqueous distillation, and used as an aromatic stimulant and carminative; also for disguising the taste of nauseous drugs. The oil is also used in cheese-making and for liqueurs.

Fig. 22.—Caraway (*Carum carui*), one of the Umbelliferæ. *b* One of the leaves; *c* Flower; *d* Fruit; *e* The two carpels of the fruit suspended by the columella (the fruit is a "cremocarp"); *f* Tap-root; *g* Flowering branch showing the compound umbel and umbellules.

It is cultivated thus: Sow in autumn in drills one foot apart, the plants being thinned to the same distance in the rows. The following July the plants are either cut with a hook at a foot from the ground, or are pulled up and kept in a barn till the seeds are fully ripe, when they are threshed out. The produce of an acre in England is from four to eight hundredweights, worth about 60s. a hundredweight.

Spirit of caraway is got by distilling bruised seed with proof spirit, or dissolving oil of caraway in proof spirit. The produce, sweetened with sugar, forms the German liqueur Kümmel.

The seeds are coated with sugar and used in confectionery. For this purpose, an open copper pan which will hold half a bushel is suspended over a charcoal-fire by three cords till it is slightly heated. About a pint of caraway-seeds are then put in, with a small quantity of syrup of refined sugar. The pan is kept turning round by means of the cords till all the seeds are coated with syrup and dried, the operation being repeated till the seeds have sufficient sugar around them.

Caraway-oil is pale yellow or colourless, with a powerful smell. The seeds yield from five to seven per cent by distilling with water. It is used for the purposes above mentioned, and for scenting soap.

The caraway has a wide geographical range of about 30°. It grows from lat. 30° N. to lat. 60° N., and is therefore able to bear great extremes of temperature.

COLOCYNTH (*Citrullus colocynthis*).

Nat. Ord. CUCURBITACEÆ.

Originally a native of the warmer parts of Asia, which has spread over the coasts of the Mediterranean basin and Portugal. The plant resembles the cucumber, being an annual plant of trailing and creeping nature. The flowers are small, solitary, and unisexual, with a persistent five-parted calyx and corolla. The leaves are hairy, triangular, and obtusely notched.

The officinal part of the plant is the fruit, a round gourd the size of an orange, divided into three cells containing a pithy matter and numerous oval seeds. When fresh, the fruit is green, but yellow-brown when dried. In this state it does not often appear in commerce, being usually peeled, when it resembles balls of white pith, and is often shown in druggists' windows. These have little smell, but an intensely bitter taste.

Colocynth is an active purgative, and, in large doses, is a violent irritant; hence it is always used in combination with other substances, usually in the form of pills.

It might be cultivated like the squill, and on the sea-coasts of Australia it would be a useful plant to introduce, as it requires but little attention.

CORIANDER (*Coriandrum sativum*).

Nat. Ord. UMBELLIFERÆ.

An annual plant from a foot to one foot and a half high. The seeds are aromatic and carminative, and much used in sauces, curries, and for flavouring gin. The tender leaves and shoots are eaten in salads and soups.

It is a plant of wide geographical range, largely cultivated in India, Africa, South Europe, and even in England, where it is sometimes known as "col," and sown along with caraway.

It likes a warm, sandy loam, and may be sown broadcast, or in drills nine inches apart, the seed being covered with half an inch of earth. The ground is kept clean by hoeing till the seed ripens. The seed is cut with hooks, and threshed in the field over a cloth — the return from an acre of land being fourteen or fifteen hundredweights. It only ripens in England in hot years.

Yields about one per cent of volatile oil, obtained by crushing the seeds, and subjecting them to aqueous distillation.

In medicine it prevents griping, and is a wholesome tonic and a valuable aid to persons of weak digestion. It is an important ingredient in Chartreuse and other liqueurs. It is largely employed in curries and other Indian dishes and confectionery.

The present price in London of coriander-seed is 15s. 6d. to 16s. the hundredweight for East Indian.

DILL (*Anethum graveolens*).

Nat. Ord. UMBELLIFERÆ.

A native of the south of Europe, Cape Colony, Egypt, &c.; is hardy, and grows in England. A biennial plant, cultivated principally for the sake of the fruits. These, when distilled with water, furnish an oil used in medicine on account of its carminative properties, which relieve griping in children and flatulence. The leaves are used in soups, sauces, and pickles for flavouring. The plant and fruit have a strong aromatic smell and taste. The seeds, or fruit, as they should properly be called, are also employed in flavouring gin.

It is sown in the place where it is to remain, in drills nine inches apart. When the plants are three inches high they should be thinned to eight inches from each other. As the seeds drop as soon as they ripen, the stalks should be cut a little before this occurs.

The crushed seeds, distilled with water, yield from three to four per cent of essential oil. The distilled water, from which this oil is skimmed, is the "dill water" of commerce. The essential oil is used to scent soaps.

FENNEL (*Fœniculum vulgare*).

Nat. Ord. UMBELLIFERÆ.

A native of the warm-temperate parts of Europe and Asia. It grows in Britain, and seems to prefer chalky soil near the sea. Is a perennial, two to four feet in height, with pinnate leaves. Is principally grown in the south of Europe for the sake of its fruits, which are used in medicine to correct purgatives. Distilled with water, these seeds give a volatile oil of aromatic odour and yellowish colour. The whole plant is distilled with water in South France in the summer, and 500

pounds of it yield one pound of oil. Both oil of fennel and fennel-water are used in pharmacy, being stimulant and carminative. The leaves are used to flavour sauces, and the seeds in confectionery.

The seeds are sown in lines, and not deeply covered. The plants are thinned out to one foot apart. They must be weeded, and last several years. The plant can also be propagated by parting the roots and planting in prepared beds. In Italy the enlarged part, just above the earth, produced by the leaf-stalks, is blanched and eaten like celery, or boiled as a vegetable. It is called "finochio." The leaves are sometimes used for garnishing. They are emblematic of grief, and give rise to the proverb, "He who sows fennel sows sorrow."

Fig. 23.—Longitudinal section of the flower of the Fennel.

Sweet fennel, *F. dulce*, is a smaller plant than the above, with larger fruit. It makes good salad, the roots being the part used. The fruit yields oil of similar properties to the preceding.

GINSENG.

Nat. Ord. ARALIACEÆ.

Is prepared from the roots of *Panax schinseng* or *ginseng*, a native of China, and from *P. quinquefolium*, a North American species, and is a medicine of high repute in China, selling sometimes for its weight in gold.

The roots are collected in winter, old roots of the wild plant being preferred. It is macerated in fresh water for three days, and then suspended in a closed vessel over the fire, and afterwards dried till it assumes a semi-transparent resinous

appearance and is hard and brittle. The pieces of root are about the size and shape of the fingers. The taste is slightly aromatic and bitter, but more distinctly sweetish and mucilaginous.

It is packed in lead-lined boxes, these being placed in larger cases, and the intervening space filled with quicklime to prevent any moisture from reaching the drug. The dose is from sixty to ninety grains in infusion, being boiled in a double kettle surrounded by water, for the same length of time that rice takes to boil.[1] The patient drinks the infusion and eats the boiled root every morning for from three to eight days, during which he abstains from tea.

In Japan the plant grows well, but is an annual. In Corea it is perennial. It is an article of considerable export from San Francisco, where it is prepared from *P. quinquefolium;* but the root of *P. ginseng* is the most valuable, fetching from \$6 to \$400 the ounce. Europeans discredit the potency of the drug, but where there is a large Chinese population it is worth cultivating.

In 1883, China imported 466,666 lb., worth £206,304; and in 1884 the imports were 402,000 lb., valued at £168,337.

JALAP (*Exogonium purga*).

Nat. Ord. CONVOLVULACEÆ.

A climbing plant, with purple flowers like those of the common convolvulus, from which it is distinguished by the stamens, which project from the tube of the corolla.

It is a native of Mexico, where it grows at an elevation of 5000 to 8000 feet. It grows in the Government Cinchona Plantation in Jamaica at an elevation of about 5500 feet, where the mean annual temperature, subject to little variation, is 63°.

[1] Encyclopædia Britannica.

It is propagated easily from tubers, in rich forest soil where the climate is moist and the situation shaded. The plants are grown in rows three feet six inches apart. Each plant requires a stake about four feet in length, round which it climbs. The tubers are dug when the stem of the plant dies down. The larger ones are sliced, but the smaller are dried whole by exposing them in the sun till the moisture is evaporated. When thoroughly dried they are packed ready for market. Jalap is rather an exhausting crop. Worm-eaten roots are preferred to whole roots, as the worms do not eat the resinous principle. Where the climate is moist, the tubers should be dried by stove-heat.

Jalap is a well-known purgative. Ten to thirty grains of the powder forms a dose. The price of the root is from 9½d. to 1s. 2d. a pound in the wholesale market.

LIQUORICE (*Glycyrrhiza glabra*).

Nat. Ord. LEGUMINOSÆ.

An herbaceous, perennial plant, growing to a height of four or five feet, with long roots, pinnate leaves, and small bluish flower (fig. 24). The stems grow thick and strong, and are used for fuel or for thatching. A rich, deep, loose soil free from stones is required; the subsoil should be of a sandy nature. If the land is stony, the roots will grow crooked, and the cultivator must endeavour to produce roots as long and straight as possible.

The land is heavily manured, forty tons of farmyard manure being applied to the acre. It is then deeply trenched with the spade to a depth of from two to four feet, the soil being laid up in ridges till March, when it is levelled and made ready for planting. Liquorice is propagated by pieces of the rhizomes, or creeping underground stems, from four to six inches

long, each piece containing two eyes. These are set in rows eighteen inches apart, with nine inches between the slips, and covered with earth. The land is kept clean and free from weeds. The roots soon send out fresh rhizomes, which grow very rapidly, about an inch underground; they are full of eyes, about two inches apart, and if left alone would soon fill the ground with inferior roots, damaging the true crop. Every November these rhizomes are raised with a fork and cut off close to the main roots. If required for propagating, they are cut into lengths, each containing two eyes, laid in heaps on the ground, and covered with straw and soil as potatoes are. Those not required for planting are sold to brewers as inferior root.

The crop takes three years to mature. In winter, after the sap has descended, the stems are cut close to the ground. A trench is then dug along the space between the rows to a depth equal to the first trenching. A rope is tied round the top and the root is pulled up as entire as possible, though much of it gets broken in the process. The roots are cleaned, and are then ready for the market.

Fig. 24.—*Glycyrrhiza glabra.* The Liquorice-plant.

The crop is very profitable. From one to four tons of roots are got from an acre, the approximate value of which should be £30 a ton. The roots are kept in sand in a dry shed.

The manufacture of liquorice is performed thus: The roots are crushed to a pulp by a millstone; this pulp is put in boilers with water and boiled. The liquor is run off from the solid matter and evaporated in copper pans till concentrated, care being taken not to allow it to burn. On cooling, it is

rolled by hand on a wooden table; the addition of a little oil may be necessary to prevent adhesion. The dried roots yield about 30 per cent of extract.

Liquorice is used chiefly in colouring porter and giving sweetness to cavendish tobacco. In medicine it is used to sweeten cough mixtures: as it is not liable to ferment, it is preferable to honey or sugar for the purpose. It is also used to disguise the taste of unpleasant drugs, and for colds. It is a well-known confection.

There are several varieties of *Glycyrrhiza.*—*G. typica* is indigenous to South Europe, and *G. glandulifera* from Hungary to China. *G. echinata* is grown in Italy; it is commonly called prickly liquorice. Liquorice is grown in England to a limited extent, principally at Mitchem in Surrey, and Pontefract in Yorkshire. It grows vigorously in Victoria: probably as the manufacture of tobacco and porter increases in Australia, more attention will be given to it by farmers.

Most of the liquorice of commerce comes from Asia Minor, Spain, Italy, Russia, and Germany. In 1876, 1096 tons were imported into England.

MANNA ASH (*Ornus europæa, Fraxinus ornus*).

Nat. Ord. OLEACEÆ.

Manna is the sweet juice from the above tree in a dried state. It is used as a medicine, chiefly for young children, who like it on account of its sweet taste.[1] It is gently laxative, from twenty to forty grains being a dose. It dissolves easily in water. The London market value is about 6s. a pound. Manna is also obtained from *Ornus rotundifolia.* Both are trees of about twenty-five feet in height. *Ornus europæa* is found in Sicily, Italy, Sardinia, Spain, and Turkey; but the production of manna seems confined to Sicily.

[1] See Chemistry of Common Life.

The trees are planted on sloping ground with an eastern aspect, at distances of seven feet apart. The land is kept free from weeds, and dug with forks once a-year. When the trees have attained a diameter of three inches, about eight years after planting, the manna is collected — the hottest season of the year being the time chosen, during the months of July, August, and part of September. Only one side of the tree is operated upon in a season, the opposite side being tapped the following year. Beginning near the ground, a row of gashes is made with a sharp knife (fig. 25), each gash being about two inches long and cut through the bark to the wood. A thick whitish juice exudes from these gashes, and is collected on leaves of the tree inserted in the wounds, or upon pieces of straw; the juice from the lower cuts being caught on pieces of tile or opuntia (cactus) laid on the ground. Every day a fresh row of cuts is made, about an inch above the last row, till the branches are reached, the best manna being got from the upper incisions. The juice hardens in eight days' time, when it is collected and dried in the sun to make it as hard as possible. The most valuable manna is collected in large pieces from the bark and known as "flake manna." That caught on tile or opuntia, along with the small pieces taken from the stem, is called "small manna." The yearly produce

Fig. 25.—*Fraxinus ornus*—The Manna Ash, and the mode of collecting the manna.

of an acre is worth from £13 to £14. When the tree shows signs of exhaustion from this continued bleeding, it is cut down, and one shoot is allowed to spring from the stump, this shoot being tapped in about four years' time.

A manna is also extracted from the *Eucalyptus vininalis* of South Australia, better known as the "white gum" tree, which also yields pitch and timber of good quality.

MASTIC (*Pistacia lentiscus*).

Nat. Ord. ANACARDIACEÆ.

P. lentiscus is a small tree found in Portugal and the Mediterranean regions. It grows on flat, dry, stony ground, and yields a resin, the mastic of commerce, obtained almost entirely from Scio and Asiatic Turkey. The only cultivation which the tree receives is keeping the soil around it clean.

To obtain the resin numerous transverse incisions are made on the bark of the stem and larger branches; from these a gummy fluid exudes which adheres to the bark. It soon thickens by exposure to the air, and in a fortnight or three weeks is sufficiently dry to collect, when it is picked off the bark and put in baskets lined with white paper. The trees are usually incised three or four times from June to September. The resin which exudes naturally from the smaller branches, is of the best quality. The total amount of resin obtainable from a large tree is from eight to ten pounds in a season. While the gum is being obtained wet weather may cause great damage. The best mastic is in the form of tears, usually of a pale-yellow colour, and semi-transparent. The resin has a pleasant balsamic odour and aromatic taste. It is chewed in Turkey to sweeten the breath and strengthen the gums. In Europe it is used by dentists for decayed teeth. Dissolved in turpentine it makes a good picture-varnish. In the London market mastic is worth about 3s. to 4s. a pound.

PEPPERMINT (*Mentha piperita*).

Nat. Ord. LABIATÆ.

The genus Mentha comprises numerous species of herbaceous plants widely distributed over the more temperate parts of the earth. The species under notice is cultivated in England, France, Germany, and in the United States in New York and Ohio. The other species of utility are—

M. viridis. Spearmint—the well-known "mint" of our gardens.

M. pulegium. Penny-royal.

M. citrata, which yields an oil with a pleasant odour like bergamot.

M. australis. Inferior to *M. piperita*, which it resembles.

Peppermint requires rich, deep, friable loam, which must be well manured and worked up into a fine tilth by frequent ploughing, harrowing, and rolling. It is usual to lay the land out into stretches or beds ten feet wide. Propagation is effected by offsets or runners from old plants: these are cut off when they are an inch or so above ground in May, and dibbled in rows sixteen or eighteen inches apart, with eight or ten inches between the plants—some preferring to have the rows only one foot apart, with the same distance between the plants. The land must be kept very clean, and free from all weeds.

In July or August, when the plants are in full flower, they are cut during bright dry weather. When young, the plants are cut with the scythe; the older plants are generally cut with hooks, the crop being cut close to the ground. The cut plants are allowed to dry on the ground, but attention must be paid to prevent them fermenting. The land receives a weeding or two before the end of autumn, when the plants are covered with straw and a thin layer of earth to protect them from frost.

The first year the crop is small, the plants not being in full bearing till the third year. After the fifth year the ground gets so full of roots that the plants are usually ploughed up and the land put to other purposes. In the second year the plants attain a height of two feet, and yield a second crop later in the season. From the second year two weedings in the year are generally sufficient to keep the land clean.

Most oil is obtained in a dry hot summer. Rain makes the plants soft and succulent, and diminishes the yield. The still should be fitted with a copper strainer, three inches from the bottom, to support the plants. The whole herb is distilled, the leaves and tops yielding most oil. The process of distillation should be carried on at as low a temperature as possible, and usually occupies two hours and a half. The still is charged with water in which the plants are boiled, the vapour condensed in a worm, from whence the product flows into a receiver, filled with taps at top and bottom. The oil being lighter than the water, floats upon it, and is let off by the upper tap. In the old process it used to be skimmed off with a spoon. The water is run off through the lower tap and used for the next charge, on account of the essential oil it contains; though some assert that by using old water the best quality of oil is not obtained. The spent herb is used as manure. The yield of oil from a ton of dried plants is from 12 to 15 per cent. The produce of an acre of herb being from eight to fifteen pounds, worth from 25s. to 60s. a pound, the return of oil is very uncertain, and authorities differ greatly in estimating the produce. It is not a very profitable crop, and entails much labour and care.

The oil, at first colourless, becomes yellow with age. It is used for flavouring by confectioners. In medicine it is employed as a carminative, aromatic stimulant, and stomachic, preventing griping and flatulence, and useful in nausea. For these purposes an infusion of the dried plant will be found useful. A little peppermint added to unpleasant medicines disguises their flavour. The plant is worth a place in most

gardens, for household use. Peppermint is highly valued for its medicinal properties by the Chinese.

POPPY (*Papaver somniferum*).

Nat. Ord. PAPAVERACEÆ.

The plant under notice (fig. 26) is one of value to mankind; for, apart from the oil contained in the seeds, the sap of the capsules (fig. 27) supplies a most invaluable drug, which is also used as a powerful and deleterious narcotic. There are two varieties of the species which are cultivated for the opium they contain: the one with flowers of a violet or reddish tint and black seeds, cultivated principally in Asia Minor and Egypt; and the other with white flowers and seeds, which is grown in India and China.

Fig. 26.—*Papaver somniferum*—Common White Poppy.

The opium poppy is a hardy, erect, annual plant, growing to a height of from two to four feet. It requires rich, moist soil, such as beds of alluvial deposit. It has been widely cultivated throughout India, the whole of China to 42° N., Persia, Egypt, Asia Minor, the south of Europe, France, England, Germany, California, Louisiana, Virginia. In the Australian colonies it has proved a success in Victoria and Queensland.

In Dr Pereira's 'Materia Medica,' a full account will be found of the manufacture of opium in Bengal. From this I have condensed the following:—

On rich land a crop of maize or vegetables is taken during

the rainy season, before preparing the land for poppies; but where the land is poor, no other crop is raised. In October the land is ploughed, and smoothed by dragging a heavy log across it. About the 1st of November the seed is sown broadcast. Three or four days after sowing, the plough is again passed through the land to bury the seed, and the whole is again smoothed by dragging the log over it. The plant is grown under irrigation. In ten or twelve days the seed germinates. When the plants are from two to three inches high, they are weeded and thinned. Frosts sometimes nip the young plants. In February the plants are in full flower. Just before the petals fall they are gathered, and formed into circular cakes one-sixteenth of an inch thick, by heating an inverted earthen or iron vessel over a slow fire. A few petals are spread on the convex surface, and as soon as a glutinous juice exudes, others are added, till a cake of the desired size is obtained.

Fig. 27.—Different forms of the capsules of the same species of Poppy (*Papaver somniferum*), from which a large portion of the opium of commerce is made. *a* Seeds natural size; *b* magnified.

In a few days, after the removal of the petals, the poppy-heads will be ready for collecting the opium. The instrument used for scarifying the poppy-heads is called a "nushtur," and consists of four blades six inches long, three-quarters of an inch wide at the broadest end, and a quarter of an inch wide at the end which is to serve as a handle. The broad end of these blades is deeply notched, and they are

bound together with cotton thread, which is also passed between the blades to keep them apart.

At three or four in the afternoon the heads (fig. 28, 1) are scarified, only one set of points of the nushtur (fig. 28, 2) being used at the time, care being taken not to cut through the capsule, but only to scarify the pericarp. The cuts are drawn lengthways down the capsule and along the elevated ridges. Each head receives from two to six incisions, according to its size. Dews facilitate the flow of juice from the wounds, but the juice is dark and liquid. East winds, which are usually damp, retard the flow of juice. A dry wind, generally from the west, and dewy nights, form the most favourable atmospheric condition, provided the wind is not too strong.

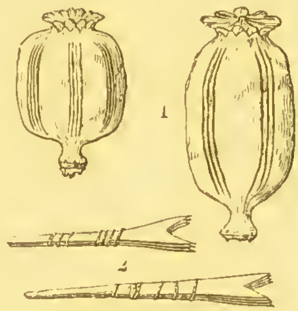


Fig. 28.—1. Poppy-heads, showing the parallel incisions. 2. Nushturs, or poppy-knives.

Early the next morning the juice is collected by scraping the capsules with an instrument of iron like a hollow trowel or scoop, called a "seetoah." This is twice drawn upwards over each wound, and the juice emptied into an earthenware vessel, hung round the waist of the collector. When fresh the juice is pinkish, but below it there is a dark fluid like coffee, called "pussewah." The collected juice is put in a shallow earthen vessel and tilted, so as to let the pussewah drain off into a covered jar.

The opium is daily exposed to the air, but never to the sun, and is turned every few days, to ensure a uniform dryness, for three weeks or a month. The drug, as prepared by the Government, is tested by subjecting a small weighed quantity to a temperature of 200° F., when, after everything volatile has been driven off, if it leaves a residue of 70 per cent it is known as standard opium.

The opium is now put in wooden boxes, each holding ten hundredweights, and occasionally stirred up till it reaches the

proper consistence. It here becomes covered with a thin blackish crust, and deepens by the exposure it receives to the air and light. If it is of a low consistence, it is placed in shallow drawers and constantly turned till it reaches the quality of standard opium. The opium is then cut into pieces of twenty pounds weight, and thrown into shallow wooden drawers and well kneaded. It is then put in large cisterns, and receives a further kneading by men who wade through it knee-deep.

The opium is packed thus: The leaves made from the petals are damped overnight to make them pliant. Some leaves are placed in a brass cup and glued together with "lewah," a mixture of inferior opium, pussewah, and the washings of pots which have contained opium. Leaf after leaf is added till the shell is half an inch thick; the opium is then put into it; the leaves, which were allowed to hang over the edge of the cup, are fixed over the upper side till the whole is caked with leaves and lewah. The ball of opium now resembles a 24-pound shot. It is then rolled in the dried and powdered leaves and stems of the poppy-plants, known as "poppy-trash," and exposed to the sun for three days. Should it become distended, it is opened to allow the gas to escape, and again closed. The "cakes" or balls of opium are then placed on open battens, which allow a free current of air to pass round them, and in two months' time are ready for packing.[1]

We must now return to the poppy-heads, which we left standing in the field, the opium having been extracted. These are cut from the stems, stored, and the seeds shaken out when dry. The seeds are pressed for the oil they contain, and yield from 40 to 50 per cent of a bland pale golden-coloured oil. The oil may be bleached by exposure to the sun. The cold-drawn oil is fit for food, and largely used to adulterate olive-oil. It is in demand for painters' purposes, as it preserves its colour

[1] A detailed account of the chemical constituents will be found in 'Chemistry of Common Life.'

better than linseed-oil. It saponifies readily, and the inferior oil is used for making hard soaps. It is also used for burning in lamps. The seeds have no narcotic properties. In India a coarse unleavened bread is made from the dry cake after the oil has been expressed. The cake is capital food for cattle, and is also used for poultices. The whole seed is prepared, like caraways, as a comfit.

The best soil for opium is a sandy loam, the produce having a dark-brown colour. Alluvial land is good, but the opium is rather darker, more liquid, and less granular. The poppies may be sown year after year if the soil is manured, and the best way to do this is by penning goats or sheep on the land. The sowings commence about 15th November in Bengal, and must be concluded in December. The seed is moistened the night before sowing, mixed with fine earth, and scattered broadcast at the rate of two *seers* to a *beegah* of land. If the land is dry, it should be irrigated before sowing, and again the day after. The land may be laid out in beds four feet wide, with a drain between every two beds.

When the plants are two inches high the land is weeded and thinned, the retained plants being three or four inches apart. A fortnight after, weed again, and thin out all weakly plants, leaving the others seven or eight inches from each other. The soil afterwards must be hoed and irrigated every two weeks. The water supplied must never be more than one inch deep.

When the green capsules are slightly coated with a fine transparent white surface and the pods harden, or if juice exudes on breaking the stigma, the collecting may begin (fig. 29). The capsules are incised every third day, from two to seven incisions being made. The collected juice should be kept in a brass vessel in a slanting position to drain the pussewah (produced by dew uniting with the sap from the incisions) from the drug. Next day transfer to shallow earthen vessels. The drug should be manipulated at least once a-week, and the pussewah kept by itself. "Everything de-

pends on the early handling of the opium, and the speedy separation of the pussewah before it deteriorates the drug." Do not expose the opium in the sun, or keep it in places where there is much smoke; free currents of air are beneficial.

In a good year a beegah of land gives eight to ten seers (of two pounds) of opium, and from two to two and a half maunds of seed.[1]

Fig. 29.—Coolies scraping the dried juice from the poppy-heads.

In the 'Pharmaceutical Journal' for 1871 there is an interesting account of the culture of poppies for opium in Queensland. The writer says that land which has been previously worked for a root-crop is better than new land, as it gives the tap-root considerable advantage. The seed is sown in drills from eighteen inches to two feet apart. This is a much better plan than the Indian one of sowing broadcast, as it will facilitate the collection of the opium. The seed is sown from the middle of May to the end of June. Most sap is got from the capsules in warm weather. The yield of opium per acre is from thirty to forty pounds, the value of the opium being £3 to £3, 10s. a pound. The poppy-heads are incised on opposite sides on alternate evenings; this is continued till the heads cease yielding sap. The opium is dried on shallow plates, and worked into a proper consistence, the drying being done as quickly as possible to prevent the opium from getting musty. The cakes formed weigh half a pound each. The capsules are worth 35s. per thousand, and the yield from an acre is from thirty-five to forty thousand.

[1] Notes on the Cultivation of the Poppy. T. A. M. Glennoe.

Opium is one of the most valuable medicines known. It is largely used, in addition to its narcotic properties, as a calmative, antiseptic, soporific, and antispasmodic. It is commonly used either in a solid form or in tincture under the name of laudanum. Morphia is an alkaloid prepared from opium. Anarcotine is a crystalline principle derived from opium. The nearly ripe poppy-capsules, when dried and deprived of their seeds, may be used for similar purposes as opium. Opium-smoking in China, when not carried to excess, has a beneficial effect in counteracting the effects of malaria. The fen-men of Lincolnshire used large quantities of laudanum for this purpose before the fens were drained.

The importation of opium into China was—in

1883, . . .	8,987,333 lb., valued at	£7,075,758
1884, . . .	8,957,466 " "	7,300,208

In 1879, 11,073,066 lb. were imported.

The London price of opium is from 9s. 6d. to 14s. 9d. a pound.

The exports of opium from India were as follows :—

	1880.	1881.	1882.	1883.	1884.	1885.
Chests,	105,507	92,190	89,338	91,798	91,963	86,578
Value,	£14,323,314	£13,600,148	£12,432,142	£11,481,379	£11,294,460	£10,882,606

The Bengal opium is produced in the Benares and Behar districts. Malwa opium being produced in native States, is charged a heavy duty on entering British territory. In the year 1883-84, the profit derived by Government from Bengal opium was £5,192,100, and from Malwa opium £2,508,490.

Opium is also produced in Persia, Asia Minor, and Egypt.

In 1883, 774,069 lb. were imported into the United Kingdom, and 425,008 lb. exported. In 1884, 490,675 lb. were imported, and 471,577 lb. exported.

SCAMMONY (*Convolvulus scammonia*).

Nat. Ord. CONVOLVULACEÆ.

Convolvulus scammonia grows on waste land in the districts round the Levant. It is principally found in North Palestine, Asiatic Turkey, Greece, and South Russia. It generally grows among arbutus and juniper bushes, as it requires support.

It is a perennial plant of climbing habit, with numerous stems, which grow to a length of fifteen feet. The leaves are sagittate, bright green in colour, and have long footstalks. The flowers are yellow and funnel-shaped, and generally in pairs on the pedicels. The officinal part of the plant is the root, which grows to a length of three or four feet, and three to four inches in diameter. The best root is found in poor hilly land.

The drug is obtained in summer while the plant is in flower. Three or four inches of soil are scraped away from round the root, which is then cut in an oblique direction about an inch below the crown. A shell is placed on the lower side to catch the juice, which exudes most freely in early morning and late in the evening. The shells are usually emptied at night, and any juice which has hardened on the cut surface of the root is scraped off, and the whole is put in any handy metal vessel, where it is allowed to harden after it has been well stirred in the sun. The average yield of a four-year-old root is about a dram. The Greek scammony is dried in an airy room upon sheep-skins, and is not exposed to the sun. The best or "virgin" scammony is thus prepared, and is exported in flat pieces an inch in thickness and four inches in length. The value in London is 23s. to 25s. a pound; ordinary, 8s. to 20s. It is often largely adulterated.

Scammony is a powerful hydragogue purgative, usually administered in conjunction with some other purgative which assists its action and lessens the griping.

SQUILL (*Urginea maritima*).

Nat. Ord. LILIACEÆ.

A native of the Mediterranean shores, found in sandy parts of the coast. The plant consists of large scaly bulbs, from which the long sword-shaped leaves spring. The flowers are borne on long-stalked spikes. The plant is perennial. The bulb is as large as a cocoa-nut, and contains a thick, viscid, acrid juice, which blisters the skin when fresh, has an acrid bitter taste, but is almost odourless.

In early autumn, when the leaves die down, the bulbs are taken up, the dry outer scales are removed, and the bulb cut into four parts. The core is cut out, and the rest is finally sliced and dried at a gentle heat or in the sun.

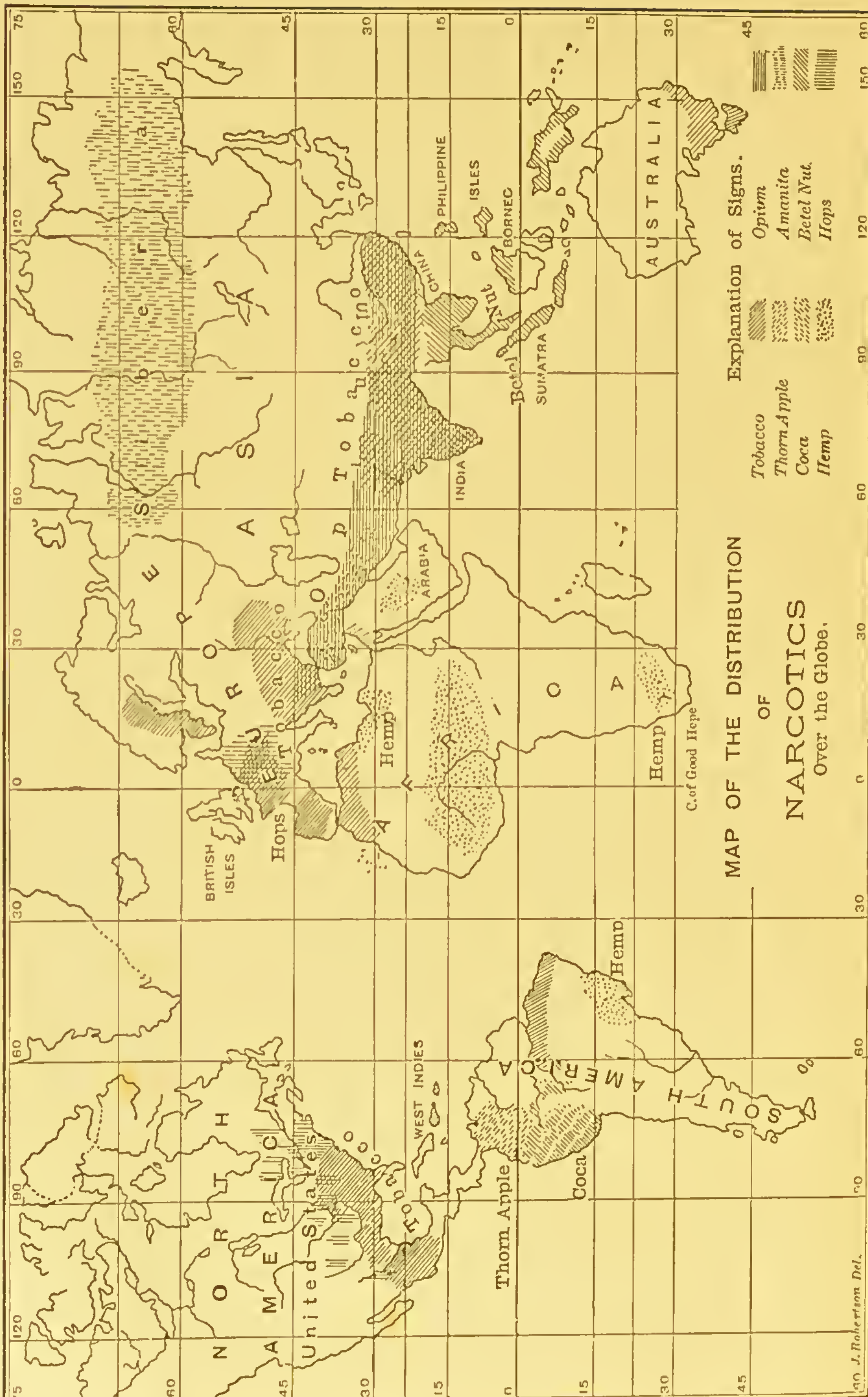
Von Mueller remarks that the squill does not require regular cultivation ; but settlers living near the coast should introduce the plant, and collect the bulbs when once it was established.

In medicine the powdered bulb is used as an expectorant and diuretic. It is often used for coughs, and in chronic bronchitis and dropsy. In large doses it acts harshly as an emetic and purgative, and in too large doses proves an acrid poison. The usual dose of the powdered bulb is from one to three grains. It is also given as tincture, and dissolved in vinegar as "squill vinegar."

TOBACCO (*Nicotiana tabacum*).

Nat. Ord. SOLANACEÆ.

Whether tobacco was known in the Old World before the discovery of America, has been the subject of much controversy. That the custom of smoking dried plants was practised in the eastern hemisphere from the most distant ages admits of little doubt, but it becomes a difficult matter to conjecture


MAP OF THE DISTRIBUTION
OF
NARCOTICS
Over the Globe.
Explanation of Signs.
Tobacco
Thorn Apple
Coca
Hemp
Opium
Amanita
Betel Nut.
Hops
NORTH AMERICA
United States
WEST INDIES
SOUTH AMERICA
BRITISH ISLES
EUROPE
ASIA
Siberia
AFRICA
ARABIA
INDIA
CHINA
PHILIPPINE ISLES
BORNEO
SUMATRA
AUSTRALIA
C. of Good Hope
Thorn Apple
Coca
Hemp
Hops
Tobacco
Opium
Betel Nut
J. Robertson Del.

what plants were smoked. The use of tobacco in Europe, as an article of luxury and medicine, began about eighty years after the discovery of Cuba by Columbus in 1492; and before the close of the sixteenth century all Europe was smoking, in spite of the interdicts of king, pope, or sultan. In 1605 tobacco had found its way to India; and not long after, the Portuguese, who had originally introduced it into Europe, took it to Japan.

According to M. A. De Candolle, the genus *Nicotiana* contains about fifty species, all of which are natives of America, excepting *N. suaveolens* of Australia, and *N. fragrans* of New Caledonia. The species most in use are:—

1. *N. tabacum.* American tobacco.
2. *N. rustica.* Syrian tobacco.
3. *N. repanda.* From Havanna.
4. *N. Persica.* Shiraz tobacco.
5. *N. crispa.* From the Levant.

Fig. 30.—*Nicotiana tabacum*—The Virginian Tobacco.

N. tabacum (fig. 30).—A native of tropical America. Grows to a height of three to six feet. The leaves are large, oblong, and lance-shaped, covered with very small hairs. The lower leaves are decurrent or attached to the stalk. The corollas (figs. 31, 32) are much longer than the calyx, of a pink colour. To this species belong two marked varieties: *N. tabacum macrophylla*, Maryland tobacco; and *N. tabacum angustifolia*, Virginian tobacco.

N. rustica (fig. 33).—A smaller plant than *N. tabacum*, which comes sooner to maturity, and is better adapted for temperate

climates. The leaves are stalked and obtuse. Corollas not much longer than the calyx, of a greenish-yellow colour. Yields a milder tobacco than *N. tabacum.* Latakia, Turkish, and Manilla tobaccos are generally supposed to belong to varieties of this species, though some believe Latakia to be a variety of *N. tabacum.*

N. repanda.—Belongs to Cuba. Corolla white. Leaves en-

Fig. 31.—Entire expanded flower of Tobacco (*Nicotiana tabacum*, L.) *s* Calyx; *c* tube of corolla; *c'* throat; *c''* limb (natural size).

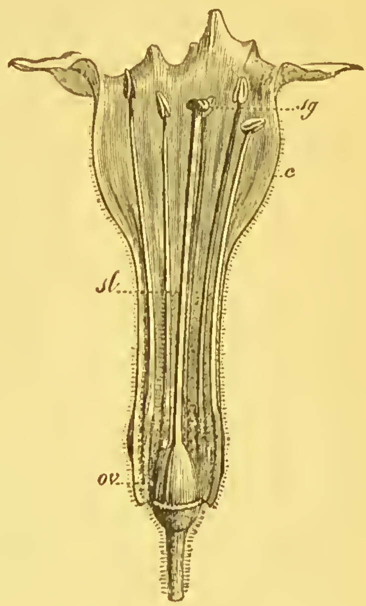


Fig. 32.—Flower of the Tobacco (*Nicotiana tabacum*, L.) opened. *c* Corolla; *ov* ovary; *st* style; *sg* stigma.

circle the stem. The leaves are used for the best Havanna cigars.

N. Persica.—The leaves are oblong, pointed, and surround the stem. Corolla white, and much longer than the calyx. The leaves make a very fragrant tobacco. After they are cut, the plants are said[1] to be stuck into the ground till they turn yellow. Some writers believe this species to be a variety of *N. tabacum.*

It is to be observed that the character of tobacco-plants

[1] Von Mueller, Select Extra-Tropical Plants.

often undergoes very considerable change when moved from their original home; and when a particular variety of tobacco-seed is imported into a country where it was previously unknown, it is not unlikely that the plants raised from it will gradually depart from the original type. This is more likely to occur where the climate and soil are different from those which prevailed in the country from whence the seed was obtained.

Fig. 33.—*Nicotiana rustica*—Syrian Tobacco-plant.

Tobacco is a hardy plant of great geographical range (see Map, p. 254), growing in most countries from Scotland to New Zealand, and from Japan to Chili—the hardiest species being *N. rustica*. The most valuable tobacco is grown in Havanna, Sumatra, Manilla, and Central America, where the climates are hot, moist, and forcing. Hence we may infer that moisture and heat are essentials to the production of the finest qualities.

Soil.—The best soil for tobacco is a rich warm sandy loam, which will work up readily into a fine tilth, and affords natural drainage. Forest-land, rich in vegetable matter and the potash contained in the ashes of the burnt trees, is well adapted for this crop, as virgin land is better than that which has been previously cultivated. Rich beds of alluvial deposit give heavy returns of large-leaved tobacco of inferior quality. Lighter soil bears smaller crops of a much finer class of leaf. If the soil is of a calcareous nature, it will suit the tobacco-plant all the better—the excellence of the tobacco-lands of Cuba and Jamaica being probably partly due to the limestone formation of these islands. The cultivation should never be attempted on wet heavy clay, good drainage being most necessary. For this reason undu-

lating land is preferable to flat land. Some cultivators in America prefer taking a crop of corn off virgin soil before planting tobacco, asserting that it prepares the land for the tobacco by rendering it more friable and more easily brought into condition. The land must be well sheltered, as strong winds are certain to do much damage to the leaves. When unsheltered, a dead hedge should be made on the weather-side of the field, by fixing straight brushwood-like broom between two wires.

Manuring.—The amount of potash and lime contained in tobacco, and the combination of these salts with acids, have considerable influence in increasing the inflammability of tobacco. The best burning tobaccos are those which contain most carbonate of potassium in their ash, while tobaccos which contain sulphate of potash and carbonate of lime rank next; but when the potash is present in the form of chloride, the tobacco burns with difficulty. The presence of nitrates also increases the inflammability of tobacco. Schlösing found the greatest proportion of nitrates contained in the midribs of the leaves, different varieties containing from 0.15 to 6.1 per cent of nitric acid in the midribs, while the leaves without the midribs contained from 0.02 to 2.0 per cent. The following analyses of tobacco will be found interesting :—

	Hungarian tobacco. Will & Fresenius.			Nürnberg. Merz.	American. Johnston.
Potash,	29.1	18.8	8.2	26.9	12.14
Soda,	2.2	...	...	2.7	0.07
Lime,	27.7	27.8	42.8	39.5	45.90
Magnesia,	7.2	15.7	13.9	9.6	13.09
Chloride of sodium,	0.9	11.4	2 2	9.6	3.49
Chloride of potassium,	...	3.9	8.5	...	3.98
Phosphate of iron,	8.8	6.8	6.1	4.2	5.48
Phosphate of lime,	...	...	...	...	1.49
Sulphate of lime,	6.4	10.1	8.0	...	6.35
Silica,	17.6	6.0	9·3	4.5	8.01
Sulphuric anhydride,	...	...	...	2.8	...
	99.9	100 5	99.0	99.8	100.00

From these, it will be seen that the manures most required by tobacco are potash and lime; and when the plant has occupied the same piece of land for consecutive crops, it becomes necessary to return them to the soil. Chemists have proved that these are best supplied by their carbonates, sulphates, and nitrates, but not as chlorides. The best artificial manures will be found to be :—

1. Carbonate of potash, or pearl-ash.
2. Sulphate of potash. Costs from £12 to £20 per ton.
3. Nitrate of potash, or saltpetre. Applied at the rate of two hundredweights per acre.
4. Carbonate of lime. Limestone and chalk.
5. Sulphate of lime, gypsum. For top-dressing the land.

Wood-ashes contain both potash and lime, and are therefore the most valuable manure. Sulphate of lime is expensive. Saltpetre is valuable: two hundredweights an acre will be found sufficient, if dug in round the plants or applied in solution. Gypsum is a good stimulant for land in good heart, but unsuited for poor land. Well-rotted pig, stable, or cattle dung is applied in large quantities to old land. In America, from thirty to fifty cart-loads of cattle-dung to the acre has been advised. But when land is very heavily dunged, the crop, though heavy, is of coarse quality. It will answer better to apply less animal manure and add wood-ashes; or to green-manure the land by ploughing in some growing crop, such as rye, adding the cattle-manure afterwards. In Holland, eight tons of farmyard manure and three tons of rape-cake were the usual application in the early part of this century. Guano and poultry-droppings are recommended by some planters.

Nursery.—Choose a warm, sunny spot, sheltered from all winds, not too far from the field, with water close to it. Having fixed the site, lay dry brushwood and branches over it, fire them, and reduce them to ashes. Do not pile the wood too high, or the soil will be burnt. When the fire has burnt down, rake off any unburnt wood. Dig the ground six inches deep. Have the beds of any length, but four feet will be

found a sufficient width, for if wider it will be troublesome to weed them and attend to the plants. Leave narrow paths between the different beds, taking the top soil from the paths and adding it to the beds, so as to raise them above the level of the paths. Edge the beds with planks, to keep the soil together, keeping the planks in their places by pegs driven in at intervals. Rake the soil both ways, and bring it into as fine a condition as possible. Tobacco-seed is very minute—one ounce containing 875,000 seeds—and a table-spoonful will produce 10,000 plants. Mix the seed with one pint of well-sifted dry wood-ashes, and sprinkle over the bed. A table-spoonful of seed will sow a bed twenty-three feet long by four feet wide. Roll the seed in with a garden-roller, or press it into the soil with a piece of board the width of the bed. The germination of the seed can be hastened by mixing it with fine, moist mould; put it in a tin, and keep it for four days on a mantelpiece above a fire, keeping the contents of the tin moist, and not allowing them to dry; when the seed shows signs of sprouting, sow it. The seed-beds must be moistened by watering when required. The seedlings should be kept free from weeds; pull these up by hand as carefully as possible. The young plants will be recognised by their bright green colour; they lie very flat on the ground. The seedlings will be ready to transplant in about eight weeks from sowing, when they are four inches high.

Preparation of the Land.—The tobacco-field must be worked up into a thoroughly friable state. It is better to plough it in the early winter and allow the frosts to pulverise it; but if this cannot be done, plough it eight inches deep a month or six weeks before planting it. If the field is to be manured, spread the manure before ploughing it. Cross-plough it if necessary. Ten or twelve days after ploughing, harrow it in the direction of the furrows. Roll it, and a fortnight after cross-harrow it.

It is a matter of great importance for the after-cultivation that the rows of plants should be straight and regular. This may be done in two ways. 1. Run a straight line across the

field with a prismatic compass, or arrange a row of sticks in a straight line, looking along them to see that they are all in line. Then run a light plough up the row, having a boy a short distance ahead to remove the sticks. Run these light furrows, three feet apart, all over the field. The next thing is to rearrange your sticks the opposite way, and run cross furrows, intersecting the others at right angles, till the whole field is marked out. 2. The same result will be got by having a long rope, with strips of red flannel passed between the strands at intervals of three feet. Tie a pole to either end; make two men hold the poles so as to stretch the rope along the line marked out by the compass or sticks; two or three boys can then run down the line sticking wooden pegs into the ground at each piece of flannel.[1]

When the land is all marked out, draw the earth together with a hoe at the points where the furrows intersect each other, or at the pegs, so as to form little hills; flatten them with the back of the hoe.

Planting.—Choose a wet, cloudy day. Loosen the best plants in the nursery-beds with a two-pronged iron fork, or piece of stick, and draw them carefully up, so as not to injure the roots. Lay them in wide shallow baskets and carry them to the field, where a plant is dropped at each hill.

Make a hole in the centre of the hill with the hand, or with a mason's short trowel; draw the earth towards you, and insert the plant at the back of the trowel, taking care not to bend the roots. Gradually withdraw the trowel so as to let the earth settle round the roots, press it tightly so to leave the plant firmly imbedded up to the collar, and pass on to the next hill. The plants must never be buried deeper than the collar, or part which is above ground in the nursery. If dry weather sets in, the plants will require watering. If the sun is strong and likely to injure them, stick some bracken or leafy twigs round each plant for shelter; two shingles set in the ground like the letter A afford good shade. The first wet weather

[1] See p. 138.

after planting, go over the whole field, and replace all dead or withering plants with fresh ones. Be careful to have a sufficient number of plants in the nursery to do this.

Cultivation.—Whenever the plants have taken root, run a cultivator or light plough down the rows, not going too near the plants. Follow with a hoe and destroy all weeds, slightly stir the surface of the hill, and draw a little fine mould round the plants. A fortnight afterwards, run the cultivator again through the field. When the cultivator cannot longer pass down the rows without injuring the leaves, stop cultivating.

In some countries where worms do terrible injury to the leaves, it is necessary to search for them on the under side of the leaves, when the latter are the size of a man's hand. This must be continued till the tobacco is ripe. Turkeys prove valuable auxiliaries in destroying worms.

Considerable difference of opinion exists as to the proper time for topping tobacco. Some top when the seed-buds are barely perceptible, others top when the earliest plants are in flower. The object of topping is to secure only as many leaves as the plant can mature thoroughly, and to throw the whole vigour of the plant into these leaves. If the plants are topped too high, the size of the leaves is diminished, the upper leaves being small and of inferior quality. If topped too low, some leaves may be lost which the plant might have supported. Any damaged leaves near the ground should be removed. From eight to sixteen leaves are left on the plant. A finer leaf, and equal weight, will be got by those who do not leave more than ten leaves, is the opinion of the advocates for low topping. After topping, suckers spring from the stem at the base of the leaf-stalks. The upper leaves are the first to put out these suckers, which must be removed from time to time, as soon as they are large enough to break off.

Cutting.—About a fortnight after topping, the tobacco will be ready to cut. Be careful neither to cut the crop too soon nor too late; let it be fully ripe. When ready to cut, the leaves turn slightly yellow and spotted, and appear rougher,

the veins of the leaves becoming more prominent. The ends of the leaves break on being doubled. Choose a fine day. Wait till the dew is off the leaves. With a sharp knife cut the stem between the lower leaves and the ground, and lay the cut plants upon the hills. The plants must not be exposed to too powerful a sun after being cut, or they will be burnt or blistered. Some tobaccos require an hour's exposure, others longer; but if the day is bright, all the cut plants should be housed by eleven o'clock. The cut plants, after lying on the hills for some time, should be turned, so as to wilt both sides equally and make them pliant. The plants are stacked in carts, the thick parts of the stalks pointing out and the leaves in.

Sometimes before cutting the plants the stems are split with a knife or chisel, from the top down to the last leaf, and the plant cut immediately after and set up on its end to wilt. Another plan is to gather the leaves separately as they ripen, string them on cord, and hang them up. A better sample of tobacco is got thus. Turkish tobacco is treated in this way, but it entails far more labour.

Tobacco-house.—An ordinary barn or shed may be fitted up for the purpose, but it is better to erect a house for the purpose, with a boarded floor, raised above the ground. One fifty feet long by thirty-three feet wide will hang seven acres of tobacco. The sides should be boarded up and down; every three feet have one plank hinged to admit air when required. Inside have a strong framework to support the sticks of tobacco. Have parallel rows of posts running lengthways, with horizontal bars fixed four feet and a half apart, on which to hang the sticks of tobacco. The tiers must be just high enough, one over the other, to keep the different tiers of tobacco from touching; continue this way to the roof of the house.

As the tobacco is brought from the field, it is spread out on the floor of the house. It is then hung on the rods to dry. This may be done in different ways: 1. By passing the split stems of the plants over the sticks. 2. By hanging the leaf nearest the butt-end of the stalk over the stick. 3. By driving

wooden pegs, six inches long and a half-inch square, into the butt-end of the stalk, with a mallet, in a slanting direction. 4. Instead of using forest sticks, use laths, and nail the ends of the stems to them. 5. By using pieces of plank five inches wide, tying the butt-ends of the plants with a half-hitch so as to keep them rather above the plank, crossing the cord to the other side over the plank, and hitching another plant a little farther on, and continuing thus till the plank will hold no more. When sticks are used they should be straight, dry, and barked, five feet long, and one inch and a half in diameter.

The sticks when filled are hung on the horizontal bars. Ten or eleven plants may be hung on each stick, and eight inches should be left between every two sticks when put in their places on the bars. The upper tiers of the house are filled first, the plants on the sticks being hoisted up by a pulley.

Curing.—Air and heat are the chief agents in curing. When the crop is all hung up, keep the building well ventilated by opening the hinged planks, and allowing as free a circulation of air as possible. In rainy, moist, or windy weather, keep the house completely shut up; opening the planks and doors as soon as fine weather sets in again. In the Northern States of America it takes nearly three months to cure tobacco. When the leaves are quite dry, and the stem brown and so dry that it will snap when bent, the tobacco is ready for stripping. The heavy American tobaccos of the Southern States are fire-cured in from four to six days; the temperature of the houses beginning at 90°, and being raised to 170° F.

Stripping.—After a spell of damp weather, when the moisture of the atmosphere has made the leaves pliant, take down several sticks and proceed to strip the leaves. The first man takes a plant, pulls off all damaged leaves, and passes the plant to the next man, who takes off the inferior leaves; he passes it to a third, who takes off the better, and the fourth man takes off the best leaves. Break off the leaves as close to

the stalks as possible. Or an experienced man may hold the butt of a plant in his hand so that the quality of the leaves can be seen, and strip off each leaf separately, arranging them on a bench according to the quality.

The stripped leaves are made into "hands." Take fourteen leaves of one quality; arrange the foot-stalks so that the ends are quite level; take a leaf and wrap it round them, beginning an inch from the ends of the stalks till about three inches of the leaf remains; separate the leaves in the middle of the bunch with the finger, and pass the end of the binding leaf through the middle of them, and the "hand" is finished.

Bulking.—In dry weather the "hands" must be bulked as soon as possible, keeping the different qualities separate. Take a hand at a time; straighten it by drawing it across the breast, and lay it down on the floor; put the next alongside the first, pressing them closely together,—and continue this till one row is finished, keeping all the butts pointing outwards. Then lay the opposite row in a similar way, allowing the tips of the leaves to overlap about four inches. As the bulk gets higher, kneel upon it, and as you lay a hand, put your knee upon it to keep it in its place. When the bulk is three feet high, lay heavy planks on the top. Take great care that it does not heat; if the least warmth is noticed, take it down, shake out the leaves, allow them to cool, and repack in smaller bulks without planks on the top. A fortnight after, rebulk the tobacco.

Packing.—The tobacco can be packed in boxes or hogsheads. The boxes are made of one-inch planed wood, three feet six inches long, two feet four inches wide, and two feet six inches deep. A box of this size will hold four hundred pounds of tobacco. Choose mild weather. Take the hands off the bulk, put the butt of the hands next the end of the box, allowing the points of the leaves to overlap. Pack closely, and keep the centre of the box packed rather higher than the ends. When the box is nearly full, put a false cover, just large enough to slip in, over the tobacco, press all down with a lever twelve

feet long, leave the pressure on a little time, and then fill up till the box will hold no more.

Before tobacco is ready for consumption, it has to pass into the hands of the manufacturer, with whom it undergoes the following processes:—

When taken from the original packages the leaf is very brittle, and has to be softened. This is done by spreading it out on the floor of the factory and sprinkling water upon it, when it is left exposed for twenty-four hours. In England the law only allows it to be damped with water, but in America it is "cased down" according to the purpose for which it is intended. The leaves of each hand are separated without untying them; the hands are then shaken into heaps on the floor and "cased." This consists in sprinkling the leaves with various "casings" or "sauces," to give the tobacco some particular flavour. Among those used are the following:—

1. Pure water, for light-coloured tobacco of natural flavour.

2. Six ounces of sugar dissolved in one gallon of water. Used to sweeten the tobacco.

3. The same as No. 2, adding a pint and a half of rum to the sugar and water, which alters the flavour but does not change the colour of the tobacco.

4. Five ounces of honey in one gallon of water gives a different sweetness to that obtained by the use of sugar.

5. Water darkened with liquorice; this makes the tobacco black and improves inferior leaf.

6. Liquorice and water, adding half a pint of molasses to each gallon of liquid. Used to sweeten black tobacco.

If the tobacco has not been bulked or thoroughly sweated, it is again bulked, after the casing, for twenty-four hours, or longer if necessary.

The next operation is stripping. The workman folds the leaf lengthways, so as to expose the midrib at the back, and holds the leaf between the finger and thumb of the left hand about two inches below the point. He then nips the midrib through with the nail of his right thumb, seizes the cut end of

the midrib between the finger and thumb of his right hand, and with a quick turn of the wrist draws the midrib over the left hand without tearing the leaf in the slightest. It is very easily done, and the quicker the better. The midribs are put on one side, and the stripped leaves sorted according to quality.

If cigars are to be made, the best leaves are stretched on a pad and smoothed out. They are then ready for binders and wrappers. Inferior leaves, after being dried, are used for fillers. The workman, seated at a table, takes one of the leaves for a filler and rolls it to the required size; he then wraps round it a strip of leaf as a binder to keep the filler in shape: at this stage it is called a "bunch." Having prepared sufficient of these, he takes the best leaves selected for wrappers, out of which he cuts, with a sharp knife, strips somewhat like a coffin in shape. Taking one of the wrappers, he covers a bunch neatly, and secures the end with gum. In order to give cigars a more uniform shape, moulds are often used. Shaping the point of the cigar requires considerable skill.

Plug or pressed tobacco is made from stripped leaf, the best leaves being used for wrappers, and the worst for fillers, all having been "cased down" according to the fancy of the manufacturer. The fillers are rolled into cylinders, covered with a wrapper, put into moulds, and pressed into the desired shape. The pressing is repeated three or four times. The cakes are then put in boxes, which are placed in a hot chamber having a temperature of from 80° to 150° F., where they remain from a few days to a month, according to the quality of the tobacco. They are then taken out, allowed to cool, and the boxes are fastened down and ready for market.

Cut tobacco is "cased down," stripped, and when "in case," or sufficiently pliable, is put into moulds and pressed sufficiently to allow it to pass easily into the cutting-machine. After being cut, it is taken to a hot open pan, where the superfluous moisture is evaporated. It is next put on cooling-off racks for twenty-four hours, when it is packed in casks to con-

dition, the flavouring being then added. The cooling is hastened by using a fan.

The midribs are put in heaps, allowed to ferment for several weeks, then ground into snuff and scented.

The most important principle of tobacco is a colourless, oily, liquid alkaloid nicotine ($C_{10}H_{14}N_2$). It boils at 482° F., turns turmeric paper brown, and restores the blue of reddened litmus. It is obtained by infusing tobacco-leaves in water mixed with a little sulphuric acid, then some quicklime is added, and the whole subjected to distillation. It is soluble in water, but is precipitated by the addition of caustic potash. Although colourless at first, it turns brown by exposure to the atmosphere. It is volatile, passing into vapour at a lower temperature than that of burning tobacco. The vapour is acrid and irritating. It is doubtful if it is present in tobacco-smoke. Nicotine is a strong poison, one drop being sufficient to kill a dog. It is found in greatest proportion in fully ripe tobacco-leaves, but diminishes if the leaves are over-ripe. The quantity of nicotine contained in tobacco varies greatly, as will be seen from the following table given by Pereira :—

Lot (France), ...	7.96 per cent.
Lot et Garonne (France), . .	7.34 "
Virginia, ...	6.87 "
Nord (France), ...	6.58 "
Kentucky, ...	6.09 "
Pas de Calais (France), . .	4.94 "
Californian, ...	4.04 "
Alsace, ...	3.20 "
Maryland, ...	2.29 "
Havanna, ...	2.00 "

In American tobaccos the percentage of nicotine varies greatly. Heavily manured Virginian contains 5.81 ; Mexican baler, heavily manured, 5.60 ; Clarksville, similarly manured, 5.29 ; while Pennsylvanian seed-leaf contains only 1.02 ; Wisconsin and Illinois seed-leaf, 0.86 ; Little Dutch Miami Valley seed-leaf, 0.63.[1]

[1] Encyclopædia Americana.

According to Nessler, the quantity of nicotine in Havanna leaf varies from 0.6 to 2.0 per cent, German leaf from 0.7 to 3.3, while Syrian tobacco contains no nicotine.[1]

Tobacco also contains a small quantity of a volatile oil,[2] one pound of leaf only yielding two grains. It may be obtained by distilling tobacco-leaves and water. It has a bitter taste, and if swallowed, causes nausea and giddiness.

There is another oil well known to smokers, being found in all strong pipes. It is of a disagreeable acrid nature, and is both narcotic and poisonous—so poisonous, in fact, that one drop will kill a cat. When mixed with acetic acid it loses its poisonous property : for this reason smokers would find vinegar useful in cleaning foul pipes.

Of the remaining constituents of tobacco, albuminoids are probably the most important. These are decomposed while the plant is curing, and cause fresh combinations, but have a marked influence on the quality and inflammability of tobacco.[3] Ammonia and nitric acid are formed during the process of curing. Leaves which have undergone strong fermentation show more ammonia, while leaves cured where they had a plentiful supply of air show more nitric acid. Boussingault[4] found dry tobacco-leaves to contain one per cent phosphoric acid, from two to five per cent of potash, and from two and a half to four and a half per cent nitrogen, partly in the form of nitrates, which shows that the plant requires soil rich in these constituents. The ash of tobacco consists of lime to the extent of from twenty-five to fifty per cent.

Tobacco-seed yields about thirty per cent of a pale, greenish-yellow, inodorous oil of mild taste.

The production of tobacco in some of the countries which grow it is given below, but an enormous amount is produced

[1] Spon, Encyclopædia of Industrial Arts.

[2] Johnston, Chemistry of Common Life.

[3] Spon, Encyclopædia of Industrial Arts.

[4] Fluckiger and Hanbury, Pharmacographia.

in Asia, South America, and Africa, of which no returns are made :—

TOBACCO CROPS FOR THE YEARS MENTIONED, IN HUNDREDWEIGHTS.

	1882.	1883.	1884.	Acreage in 1884.
Germany,	767,067	767,697	928,100	52,095
Holland,	40,011	61,515	...	...
France,	334,801	292,152	320,029	32,802
Hungary,	1,378,960	1,088,856	1,206,342	144,176
United States,	4,581,049	4,031,657	4,821,428	702,612

The consumption of tobacco in the principal European countries and British possessions is enormous, as the following table shows :—

	Imports in Pounds.		Exports in Pounds.	
	1883.	1884.	1883.	1884.
Russia,	3,096,000	2,880,000	...	...
Norway,	3,881,244	4,227,272	...	...
Sweden,[1]	7,200,093	7,769,492	...	...
Denmark,	7,558,654	7,936,499	...	...
Hamburg,	56,973,400	51,573,600	...	...
Do. cigars,	2,314,200	2,419,992	...	...
Germany,	68,950,156	77,981,487	8,060,909	15,041,198
Holland,	34,724,020	46,665,292	4,207,436	4,028,912
Switzerland,	11,213,180	11,405,020	927,960	913,440
Italy,	20,922,572	28,744,568	...	...
Austria,	28,672,820	31,612,680	...	...
United States,	14,893,000	12,955,000	235,628,000	207,158,000
do. cigars,	830,000	892,000	19,438,000	17,766,000
Canada,	279,867	420,297	...	...
Lagos,	1,077,817	1,261,623	...	...
Cape Colony,	286,582	229,815	...	...
Queensland,	813,880	1,026,781	...	...
Do. cigars,	41,949	58,097	...	...
New Zealand,	£116,199	£97,232	...	...
Tasmania,	26,303	18,531	...	...
South Australia,	639,271	679,116	...	...
Victoria,	1,956,052	2,135,687	...	...
New South Wales,	1,805,514	1,636,863	562,275	619,293
Do. cigars,	336,267	298,531	...	...

[1] For 1882 and 1883.

The consumption of tobacco in the United States is very great, and due chiefly to the high wages of the working classes and the free open-air life led by so many of the inhabitants. In 1882-83 the consumption in the States was—171,135,751 lb., including cigars. In 1883-84 the consumption of manufactured tobacco was 174,196,064 lb.

IMPORTS AND EXPORTS OF TOBACCO OF THE UNITED KINGDOM.

	1881.	1882.	1883.	1884.
IMPORTS—				
Manufactured,	3,084,590	4,086,520	3,121,174	3,165,336 lb.
Value,	£1,216,407	1,398,691	1,065,861	959,555
Unmanufactured,	48,195,897	36,075,370	56,475,199	53,530,407 lb.
Value,	£1,375,225	1,152,549	1,794,966	1,756,251
EXPORTS—				
Manufactured,	1,170,875	1,413,792	1,214,429	1,388,077 lb.
Value,	£163,677	186,150	178,048	203,724
Unmanufactured,	8,182,419	7,849,622	8,953,243	7,306,069 lb.
Value,	£215,398	242,499	269,399	207,009
RETAINED FOR HOME CONSUMPTION—				
Manufactured,	1,332,208	1,444,831	1,459,411	1,530,183 lb.
Unmanufactured,	47,999,489	48,570,962	49,092,803	50,132,723 "
Consumed per head of the population,	1.41	1.42	1.42	1.44 "

APPROXIMATE VALUE OF TOBACCO IN LONDON AT 1ST APRIL 1886.

	Per pound. s. d.		s. d.
Ohio—			
Fine Yellow,	0 11½	to	1 1
Yellow,	0 9	"	0 10
Brown to Colory,	0 5	"	0 8
Maryland—Brown to Colory,	0 3½	"	0 9
Algerian,	0 3	"	0 8
Brazil,	0 5½	"	1 0
China,	0 4	"	0 6
Columbian,	0 3	"	1 9
Cuba and Yara,	0 5	"	1 8
Dutch,	0 4	"	0 6
Esmeralda,	1 1	"	1 10

	Per pound. s.	d.		s.	d.
German, stemmed,	0	5½	to	1	4
Do. do. for cutting,	0	6	"	0	7
Greek,	0	4	"	0	5½
Havanna,	0	8	"	5	0
Japan, for cutting,	0	3½	"	0	6½
Java,	0	5	"	0	10
Latakia,	0	3½	"	0	7
Manilla,	0	7	"	3	6
Macedonian and Trebizonde,	0	3	"	0	6½
Mexican,	0	6	"	2	6
Palmyra,	0	7½	"	1	3
Paraguay,	0	3½	"	0	5
Porto Rico,	0	4	"	0	10
St Domingo,	0	4½	"	0	8
Seed-leaf,	0	3¾	"	1	3
Sumatra,	1	3	"	4	6
Turkey,	0	5	"	0	8

TANNING MATERIALS, Etc.

SUMACH (*Rhus coriaria*).

Nat. Ord. Anacardiaceæ.

A native of the Mediterranean countries of South Europe. The dried leaves contain about 30 per cent of tannin, and are greatly used in preparing light leathers. The plant likes a loose calcareous soil, probably from the good drainage it affords, as stagnant water is fatal to it. The cultivation is easy, and well suited for dry soils. The land is deeply ploughed, and laid out in rows from two to four feet apart, marked by deep furrows. The usual method of propagation is by young shoots taken from the foot of an old plant, or pieces of the running roots. It grows readily from cuttings of matured wood, which should be from a foot to eighteen inches long, and struck in manured beds before being planted out. Strong plants can also be raised from seed, but these do not come to maturity so quickly as the two former ways. In spring the cuttings are placed in the rows at two feet apart. While the young plants are growing, the land must be kept clean and fresh by running a cultivator or plough between the rows from time to time. When the plants are firmly established in the ground the stems are cut back to a length of eight inches, and then allowed to grow as they please. Suckers from the foot of the stem must be removed, unless they are wanted for propagation.

The plants yield their first crop of leaves the year after planting, in August. After the first crop the quantity of leaves increases, the quality improves, and the gathering takes place earlier in the year. In Italy the lower leaves are picked in May, as soon as they come to maturity. The next picking is late in June, or early in July, when all the branches with matured leaves are cut off as soon as the leaves are full-sized. The pruner cuts the branches with his right hand, letting them fall on his left arm. When his arm is full he lays them on the ground with the thick ends of the stems in the direction of the wind, so as to protect the leaves as much as possible from injury. The leaves on the young shoots will be ready in about three weeks after the others are gathered. When the leaves are only picked by hand, the operation is performed three times in a season, usually in May, July, and September. This is followed by a pruning in winter, the plants being cut down to eight inches above ground.

The leaves are either dried in the open air where they grew, or are laid out in a barn and frequently turned with a wooden fork. While the leaves are drying they must be most carefully protected from rain, and exposed to a free circulation of air; but too much solar heat is said to be injurious. When the leaves have been got by pruning, they are threshed with flails to separate the leaves from the twigs. The broken leaf is then crushed in a mill consisting of two heavy rollers revolving in a bed, after which it is ready for packing. The price of Sicilian sumach is from 15s. to 16s. 6d., Spanish 10s. to 11s., a hundredweight. The plant lasts for ten or fifteen years. The average produce of an acre is rather over a ton.

Sumach is also used in dyeing, yielding a variety of tints with different mordants. The leaves are principally used for yellow and black, and the roots give a red dye. Many others of this genus are valuable plants. *R. cotinus*, or Venetian sumach, yields a yellow dye, the "young fustic" of commerce. It is an ornamental shrub. The leaves are used in dyeing

turkey-red, and the whole plant for tanning purposes, being nearly as valuable as the preceding. It is chiefly obtained from Spain. *Rhus pentaphylla* is used by the Arabs for tanning morocco leather. *R. glabra* and *R. copallina*, natives of North America, are of some commercial value. *R. coriaria* is principally cultivated in Sicily.

Rhus cotinus contains about 24 per cent of tannin. It imparts a light colour to leather, and considerable firmness. The leather is soft and pliable.

In 1883 the importation of sumach into England amounted to 14,876 tons, valued at £215,298; and in 1884 to 11,704 tons, worth £165,631.

BLACK WATTLE (*Acacia decurrens*, var. *mollissima*).

The Acacia family is widely distributed in the warmer parts of the globe. They are generally shrubs, which are of more or less utility, especially as tan-barks and for the gum they yield. Among barks for tanning purposes the one under notice is unsurpassed. It yields from 30 to 54 per cent of tannin, and is said to go as far as three and a half times its weight of oak-bark. The following list gives some of the different varieties of Australian acacias, the bark of which is used in tanning:—

1. *A. decurrens.* Common wattle. Victoria.

2. *A. decurrens*, var. *mollissima.* Black wattle. Victoria. Small tree. Contains 30 to 54 per cent tannin.

3. *A. dealbata.* Silver wattle.

4. *A. melamoxylon.* Black-wood or light-wood.

5. *A. saligna.*

6. *A. pycnantha.* Broad-leaved or golden wattle. Victoria and South Australia. Grows to thirty feet. Dried bark contains 30 to 45 per cent tannin.

7. *A. binervata.* East Australia. About forty feet in height. Used for tanning. Not so valuable as No. 1.

8. *A. harpophylla.* South Queensland. Ninety feet.

9. *A. implexa.* Victoria, New South Wales, Queensland.

10. *A. leiophylla.* South-West Australia. Small tree. Bark contains nearly 30 per cent Mimosa tannin.

11. *A. retinodes.* South-East Australia. A good tanner's bark.

The seed of the black wattle costs 5s. an ounce in Melbourne, and the ounce contains from 35,000 to 50,000 seeds. These should be soaked in warm water before sowing. The tree will grow on poor sandy land, but it succeeds best when grown in good soil. The land is all the better for being ploughed; but if it is sandy, this is not necessary. In the latter case it is sufficient to walk in a straight line with a hoe, breaking up small pieces of ground every six feet and dropping three seeds into each, covering them with half an inch of earth. The lines should be six or eight feet apart, or furrows may be run with the plough at similar distances apart, and the seed sown as above described. When the plants are three or four feet high the lower branches are removed, so as to leave a good straight stem to the tree. The bark may be harvested in from five to ten years—the older the trees the more valuable is the bark. Sir F. von Mueller says one pound and a half of black-wattle bark goes as far as five pounds of oak-bark for tanning purposes.

This is one of those simple, inexpensive cultivations which show a good result, and yet are apt to be overlooked. The primary cost of land, in Australia or New Zealand, suitable for the purpose, should not be over £2 an acre: £6 per acre is an ample allowance for buying the land, seed, ploughing, pruning, superintendence, and fencing. Stripping the bark will cost about £1 a ton; baling it, 10s. a ton; carriage to market, say £1 a ton; and cutting the trees and extras, say

10s. The land planted with trees 6 × 6 feet apart, or 1210 to the acre, should show the following results:—

The fifth year—400 trees might be cut, which, at fourteen pounds of bark each, would yield two and a half tons, at £5 a ton, . . .	£12 10 0
Less stripping, baling, carriage, and cutting, at £3 a ton, ...	7 10 0
	£5 0 0
Sixth year — cutting 400 trees, yielding twenty pounds of bark each, would give, roughly, three and a half tons, at £5 a ton, . .	£17 10 0
Less stripping, baling, carriage, and cutting, at £3 a ton, ...	10 10 0
	£7 0 0
Eighth year—cutting 400 trees, yielding twenty-five pounds of bark each, giving, roughly, four and a half tons of bark, at £5 a ton, . .	£22 10 0
Less stripping, baling, carriage, and cutting, at £3 a ton, ...	13 10 0
	£9 0 0

Or a total of £21 per acre profit—from which, deducting the original price of the land, and planting and cultivating expenses, £6, would leave a profit of £15 an acre, and the land fenced. As one lot of trees were cut, others would be planted in place of them, and the next cutting would take place at the end of the tenth year, and so on. No allowance has been made for the timber, which would be worth about 10s. a ton. The above estimate is lower than any that I have seen—the net profit being generally put at £25 per acre at the end of the eighth year.

The wood is used for cask-staves, spokes for wheels, axe-handles, and makes excellent firewood, and rails for fencing.

The following table gives an idea of the size of wattle-trees in Victoria :—

	Age of tree.	Diameter, three feet from ground.
	Years.	Inches.
Black wattle from Glenisla to Dunkeld, Western district, ...	18	20
Black wattle from Bairnsdale, North Gippsland, .	20	16
Black wattle from Goulburn district, . .	6	7
Black wattle from North Gippsland, limestone formation, ...	6	5
Black wattle from South Gippsland, heavy forest-land, ...	25	17
Golden wattle from Wallington, Portarlington, and Queenscliff, ...	9	8
Golden wattle from Avoca and Castlemaine, .	10	7½

The bark should be stripped in summer or late in spring, as bark stripped in wet weather loses a portion of its tanning properties. After a year's storage the bark is said to improve in strength. Bark grown on a limestone formation is of inferior strength for tanning.

CORK-OAK (*Quercus suber*).

Nat. Ord. CORYLACEÆ.

Is a native of the countries bordering the Mediterranean. It is unable to stand much cold, but does not require much heat, the tree being adapted for temperate countries with equable climates; yet a warm climate hastens the growth of the bark. The tree grows in warm situations in England. The countries which produce the best cork are: France; Italy, where the best comes from Tuscany; Sardinia; Portugal, principally from Alentigo; Algiers; Spain, chiefly from Catalonia and Valencia, &c. In Algeria there are 2,500,000 acres of cork-oaks, of which only an eighth part is made use of. This should not be forgotten by intending cultivators of

this tree. In France the tree is not cultivated north of La Rochelle (lat. 46° 9′ N.); the departments where the cork oak is grown being Charente Inferieure, Gironde, Landes, Lot et Garonne, Basses Pyrénees, Var, and Alpes Maritimes. The French cultivate three varieties of this oak—*Q. suber*, *Q. pseudo-suber*, and *Q. occidentalis*.

Granitic and schistose soils suit it best; calcareous soils are unsuitable. Shelter is necessary. The tree will grow on rocky ground.

The acorns are sown in furrows or trenches so as to leave from twenty to forty feet between each tree. They are planted one inch and a quarter deep. If the turf which covered the ground has previously been burnt, the ashes will make a good manure for the young trees. The usual plan is to plant rows of vines six feet apart; the rows of acorns are thirteen feet apart, and the young oaks benefit from the shelter of the vines. After twenty-five years the oaks destroy the vines, which are then uprooted, after having paid all expenses and given the cultivator a profit besides. In the department of Landes *Pinus maritima* is grown instead of vines, and cut when the oaks no longer require their shelter; but the pines should be planted two years before the oaks.

The cultivation is simple. At first the soil should be ploughed once a-year, afterwards every second year. At the end of the first year after planting, the young oaks should be seven inches high; at three years old, twenty inches; at six years old, three and a half feet, when they will require less shade. The lowest branches of the young oaks are removed, and pains must be taken to develop the stems as straight and regular as possible. The lowest branches left should be shortened for the same reason, but all branches should be gradually removed for half the height of the trunk. By the time the trees are twenty years old they should be twenty-seven feet high, when they should be thinned out till the trees are twenty-seven feet apart. They should then show a clean stem for thirteen feet above ground, and the stems

should be ten inches in diameter. After this age the trees receive no further attention. The turf should now be allowed to cover the ground, and may be used for grazing sheep.

At this age the first barking takes place, but only to a height of five feet above the ground; at each successive barking this distance is increased about two feet and a half. The bark is taken off in summer when the sap is running, but the operation must not be performed in wet weather, or in seasons of drought. In barking, care must be taken not to hurt the mesophlœum or inner layer,[1] or the tree will fail to renew its bark. The workman usually takes advantage of a crack in the bark, and makes a cut down to the ground the length of the sheet of bark to be removed. He then makes another parallel to it, and two horizontal cuts above and below; but these cuts must on no account penetrate to the wood, but only be as deep as the suberous layer, or outer bark. He then beats the bark smartly to loosen it, and, introducing the wedge-shaped handle of his hatchet, prises up the bark and removes the loosened sheet. The sheets of bark, or "planks," as they are called, are curved, and must be straightened. This is done by piling them in open sheds with the concave side downwards, so that air circulates freely. In two months they will have lost one-fifth of their weight. They may also be straightened by heating them over a fire and pressing them on a flat surface under heavy stones.

In France the trees are not barked again for ten or twelve years. In Algeria, owing to the warm climate, the trees may be re-barked in eight years, and the first barking takes place at fifteen years after planting. Culture of the soil hastens the renewal of the bark, but over-culture injures its quality. The branches yield a fine cork, but it is slower in growing than that of the stem. The bark is taken off the trees during one hundred and fifty years; after that age the quality begins to deteriorate, and the trees are cut for timber. When trees are barked in cold or dry weather, the part barked should be

[1] This is called the "mother-bark" by the cork-peelers.

coated with a mixture of powdered chalk and clay. In the department of Landes, the oaks only become really profitable at the age of forty, the bark till then being of poor quality. At from eighty to one hundred years of age, most bark is obtained. When at its best, an oak gives from one to two hundredweights of bark, but eight hundredweights have been taken from a single tree. In barking the oaks, the workman must be guided by experience, as all the trees do not renew their bark equally well, some taking longer than others. The pores in the sheets of bark are closed by boiling the planks, then scraping the surface, and afterwards exposing them in the sun to dry.

The bark taken off first is hard, rough, and the surface is furrowed. It is only used for buoys, floats, bee-hives, and for artificial rock-work in conservatories and small gardens. The uses of the true cork are endless. In different countries we find it used for all sorts of purposes: from crosses to coffins, armour to kitchen-pails, pillows to horse-shoes, this most useful substance is employed. In England it is largely employed in making linoleum, kamptulicon, and other floor-cloths. The bark of *Quercus suber* contains about ten to twelve per cent of tannin, and is worth £8 a ton for tanning purposes. It is also used for making lamp-black.

The cork-oak grows in Algeria to an elevation of 3200 feet, and in the south of France to about 2000 feet. The process of barking increases the life of the tree. Those trees which yield small bitter acorns give a coarse cork, the trees which bear large sweet acorns a finer cork. The progressive value of the bark may be inferred from the results of a plantation in Estremadura, where the first stripping of bark was let for $200, the second for $5000, and the third for $10,000.[1] The cork-oak has been introduced into California, Cape Colony, Australia, and New Zealand. In the last-named colony it proved a success, and the bark was of good quality; it grew in the neighbourhood of Auckland. For the production of good

[1] Pharmaceutical Journal, 1880.

marketable bark a mean annual temperature of 55° is required.

The tree requires considerable moisture, but the climate of Algeria suits it well, where the average rainfall is twenty-nine inches, and the mean annual temperature is 64°.8, at Algiers. Where the principal cork-forests are found, there is probably an increased rainfall, and a mean temperature of from 55° to 60°. The cork-oak grows to a height of forty to fifty feet. The timber is valuable. The wood is of a brown colour, and is very tough, but it is very apt to warp. It makes good piles, and is used for charcoal.

In Europe the cork-oak grows as far north as latitude 45°; beyond this parallel it ceases to be of value.

31,342 tons of rough cork were exported from Portugal in 1884; the value given was £445,050. The same year the Spanish exports were valued at £533,840, which is about the average of the last five years.

WILLOW or OSIERS (Genus *Salix*).

Nat. Ord. SALICACEÆ.

According to Professor Anderson of Stockholm, there are one hundred and fifty-eight species of willows. These vary in size from *Salix alba*, the white willow, which attains a height of eighty feet, to the arctic willow, *S. polaris*, which is only an inch in height. Many species of willow are of great utility for basket-making, hoops for casks, and similar purposes, the young shoots being very tough and flexible—the following species being among those most in use :—

S. viminalis, the Osier.—Grows to a height of about twenty feet. The leaves are from four to six inches long and very narrow; the edge is wavy; they grow very straight, and terminate in a sharp point; the lower side of the leaf having a

silky appearance. Is a valuable variety, giving excellent rods, which, when two years old, make the best hoops. This species is suitable for land which is subject to periodical inundation. It is very hardy and a strong grower, the rods being from ten to twelve feet in length.

S. fragilis, the "Crack Willow," derives its name from the tendency of the branches to break from the stem on the slightest pressure. Grows to a great height, and furnishes useful timber. The leaves are alternate, lanceolate, serrate, and very sharply pointed, from three and a half to five inches in length. The upper side of the leaf is bright green, the lower of a greyish tint. The young shoots of a year's growth are from five to seven feet in length, and used for basket-work and hoops; they are apt to branch early, and if allowed to grow for more than a year become brittle. The timber of the tree makes good charcoal. The bark contains a considerable quantity of salicine.

S. alba, Huntingdon or White Willow.—Attains a height of eighty feet. The leaves resemble those of the preceding variety, but are smaller, usually from three to four inches long; the edges are finely serrate. The leaves are often silky on both sides, which gives them a silvery sheen. The rods are valuable for cask-hoops. The bark of the tree is used for tanning glove-leather, to which it imparts a pleasant odour.

S. vittellina, the Golden or Yellow Osier.—Allied to the preceding. The young shoots are of an orange colour, very flexible, and suited for the finest basket-work, those of a year's growth being from four to six feet long.

S. rubra, Red Willow.—From ten to twelve feet in height. Is one of the dwarf willows much grown in osier-beds. The shoots of a year's growth are from three to six feet long, of a reddish colour, very tough and elastic, and suited for the finest basket-work. The leaves are greyish on the under side, from three and a half to four and a half inches long, resembling those of the break-willow in shape. The catkins show before the leaves. This sort is suited for hedgerows.

S. triandra attains a height of thirty feet. A species of great excellence for all wicker-work. Von Mueller states that this willow, the third year after planting, yields twelve tons of rods to the acre, which are worth £3 a ton. The leaves are smooth and less pointed than those of the other species. The yearly shoots are five or six feet long and very tough.

S. purpurea.—This species has a very bitter bark, which cattle do not care to eat; for this reason it may be used as a hedge-plant. It is commonly known as the "bitter purple willow." The bark is rich in salicine. According to Von Mueller, it will yield annually from four to five tons of rods in good soil, the shoots attaining a yearly growth of from seven to thirteen feet. It is a small tree, distinguishable by the leaves, which are sometimes alternate and sometimes opposite to each other. They are only serrate towards the points. The shoots, although not long, are numerous, and suited for the finest wicker-work.

S. caprea, the "Goat Willow."—The leaves are large and broad, with wavy edges, the lower side covered with a white down. The shoots are used for hoops, the bark is rich in tannin, and the timber is of some value. It grows to a considerable size.

Good osier-rods should be long and thin, with few or no branches and little pith. They must be tough and elastic, presenting a smooth surface when peeled, and should split easily.

Soil and Situation.—The soil should be deep, rich in humus, and, if possible, on a limestone formation. A rich loam is suitable. Though osiers will grow on light soil, yet the shoots are not so vigorous as when grown on rich land. Clay is not good. A subsoil of peat is favourable, provided there is an upper stratum of good soil eighteen inches deep. The soil need not be absolutely wet; it is only necessary that it should be moist and fresh. The soft-wooded willows prefer moister land than those which have harder wood. Stagnant water has

an injurious effect on the shoots, therefore marshy land should be drained. The roots of other trees and their shade hinder the growth of osiers. The banks of muddy streams are the best situations for osiers, where the land is sometimes flooded and a fertilising deposit left. The beds must be protected from the inroads of cattle.

Planting.—In autumn the land is broken up to a depth of sixteen or eighteen inches, the top soil being buried as deeply as possible. The following spring the land is well harrowed and then rolled, when the shoots are planted. In the south of France it is not unusual to plant in autumn. The shoots must be closely planted together to ensure their growing straight and free from side branches, and to keep down weeds. In France, those osiers which are intended for the finer wicker-work are planted in rows one foot apart, the distance between the plants being eight inches; when the shoots are not to be split, the rows are sixteen inches apart, with one foot between the cuttings. In England, the distance between the rows is eighteen inches, the cuttings being placed a foot apart for the finer sorts, and double these distances for coarser kinds. In planting closely together, a wooden frame is occasionally used to indicate the distance apart, having notches to show the position of the sets. The cuttings should be about a foot in length, as thick as the finger, and taken from vigorous shoots of one or two years' growth. These are pushed into the ground till the top of the cutting is level with the surface of the soil.

Cultivation.—The land is turned over during the summer, and after the osiers are cut it is dug with forks. Top-dressing the beds with earth occasionally is practised in France. Where the land is not flooded in winter, this has a beneficial effect, as the osier-stool has a tendency to rise above the level of the soil. An application of marl corrects any acidity there may be in the land, and acts as a stimulant to the willows. Where the climate is very dry, the land may be occasionally irrigated with advantage; but the irrigation should take place in the evening.

The shoots produced the first spring after planting are of little value, still they must be cut to make way for a better crop the following year. The crop of the third year will repay all outlay upon the plantation. The cutting takes place at different times, according to the uses to which the osiers are to be put. The rods intended for use with the bark on are cut any time during the winter, a sharp bent knife being used for the purpose, and the rods separated as close as possible to the level of the ground. They are left to dry for five or six days to get rid of the sap, which might cause them to heat; all leaves, &c., are removed, and the rods are tied into bundles.

The rods which are to be peeled are not usually cut till the end of winter. They are cut close to the ground and tied in small bundles. The butts of the stalks are put in a ditch of water, so as to immerse them a few inches deep, and the rods kept upright, the upper ends resting against a support to keep them perpendicular. In time of frost they should be protected by a little straw, as the frost may prevent the bark from peeling readily. When the buds on the rods begin to open, the peeling takes place. The process may be retarded by taking the bundles out of the water and keeping them in a cellar. Willow-rods which are to be "peeled off" are set on end till they are sufficiently dry to stack or house. These dried rods are steamed or boiled, and make very durable baskets. The red and yellow osiers which are to be split are cut early in winter, taken to a cellar or other cool place, and split before they are dry.

There are special machines for barking osiers. A simple one is made of half-inch iron rod like the letter V, only longer. The osiers are drawn through the middle and the bark removed. The rods may also be drawn between two teeth of hard wood, which take off the bark. Another simple way to remove the bark is by means of two hazel saplings, with one end of each fixed. The upper sapling is pressed down so as to hold the willow tightly, when it is smartly drawn through between them, leaving the bark behind. The peeled willows

are set up on end in the sun to dry, resting them against a wall or fence. They are then tied tightly in bundles, which contract as the rods dry, when fresh rods are inserted or the bundles retied. The rods which compose these bundles should be as nearly as possible of one size, the ends being kept straight and tidy.

Willows are liable to be attacked by the larvæ of cockchafers, which eat the roots. A little beetle, the *Chrysomela populi*, injures the French beds by eating the leaves of the osiers. Saw-flies are often troublesome. Hail sometimes does considerable damage.

The duration of an osier-bed is about twelve years, after which the willows should be grubbed out, as the profits will then be, as a rule, inconsiderable. It is just possible that by manuring or warping the land it might be soon in condition for another planting. Von Mueller calculates the raw produce from an acre to give an average yearly return of from six to seven and a half tons, worth from £2, 10s. to £3, 10s. a ton.

Other Uses of Willows.—The bark of most species of willow contains a neutral bitter principle called salicine. It is found to a considerable extent in *S. purpurea*, *S. fragilis*, and other members of the family.[1] It is obtained by chopping the bark into small pieces and boiling it; the infusion is concentrated, and boiled with litharge till the decoction is colourless. The dissolved oxide of lead is removed by the addition of sulphuric acid, and afterwards by sulphuret of barium. After the separation of the sulphuret of lead the liquor is evaporated, when the salicine is found in crystals, and purified by repeated solution and crystallisation. It has tonic properties similar to sulphate of quinine, but is less powerful, and less liable to irritate the stomach. It is used in fevers and for dyspepsia; ten to thirty grains form a dose. For household use, two ounces of willow-bark boiled in two pints of water for twenty minutes, and strained, forms a useful decoction. A small teacupful forms a dose, which may be repeated two or three times a-day in the

[1] Pereira, Materia Medica.

absence of fits of ague. Willow-bark, or salicine, is tonic, restorative, and antiperiodic, and may be used for fevers, intermitting neuralgia, and for some diseases of the skin.

The wood of the willow makes excellent charcoal, and is therefore valuable in the manufacture of gunpowder. Being light, soft, and elastic, it is useful for purposes where it is likely to meet with sudden concussions which would split ordinary timber: hence it is employed in making the blades of cricket-bats, and for planking stone-carts. Thin strips of it are used in the manufacture of hats. The Bedford and white willows yield the best timber.

The bark of the crack-willow is richer in tannin than oak-bark. From 480 pounds of Leicester willow-bark Sir Humphry Davy found the yield of tannin to be thirty-three pounds, while the common willow gave only eleven pounds. *S. alba* and *S. caprea* are of value as tanning barks.

DYE-PLANTS.

ALKANET (*Alkanna tinctoria*).

Nat. Ord. BORAGINACEÆ.

A NATIVE of South Europe and the Levant, cultivated to a considerable extent in the south of France. It is hardy, and will grow in England, but the quality of the root deteriorates when grown in too cold a climate. The roots contain a colouring matter, "anchusin," which is insoluble in water, but dissolves freely in ether, alcohol, and oil. It colours all unctuous substances, and gives a beautiful crimson tint to wax: hence it is used for staining candles. With alkalies it gives a blue dye; with sulphuric acid, amethyst. It is used for dyeing silk materials violet, when previously prepared with alum mordants; when iron mordants are used, it affords shades of grey. It yields brilliant colours, but is not used for dyeing wool. Mixed with oil, it is employed for staining wood and in imitating rosewood. Wax coloured with alkanet gives a flesh-coloured stain to warm marble, to which an infusion in alcohol gives a deep-red colour. Mixed with lime-water, it is used to colour walls. Being perfectly harmless, it is employed in medicine for colouring ointments and lip-salves. It is inodorous and astringent, and is sometimes used to colour cheese, wine, varnish, &c.

It likes a sandy soil, and will grow in almost pure sand. It

is propagated by sowing the seed in beds in spring or autumn, and planting out the seedlings in rows two feet apart. The value of the root is about 30s. a hundredweight, small roots being preferred to large, as the colouring matter is contained only in the cuticle.

MADDER (*Rubia tinctorum*).

Nat. Ord. GALIACEÆ.

The cultivation of this valuable dye-plant (fig. 34) is decreasing greatly since the discovery of the coal-tar dyes. It is still, however, of some commercial importance.

Probably madder originally belonged to India, but it is now widely spread over Asia and Europe. The best madder comes from Turkey, that from France ranking next. Holland used to produce large quantities. It was also cultivated in Italy. In the south of Russia and parts of Central Asia it grows wild. The best dye is got from roots grown in a warm climate.

Fig. 34.—Flower of Madder (*Rubia tinctorum*, L.), in longitudinal section, and showing the introrse anthers. *ov* Ovules; *d* Disc.

Madder is a hardy perennial plant; the stalk and leaves are hairy, and used in France to polish metals, and as food for cattle. Propagation is effected by offshoots from the roots. A deep rich free soil suits it. In spring the shoots are planted in furrows three feet apart, a distance of one foot being left between the plants. The land is kept clean, and the stems of the plants cut off at the end of autumn for fodder. The roots are gathered in October of the second or third year;

but the older plants yield a much greater weight of roots and give a better quality of dye. The roots are dug up with forks, care being taken not to break or damage them; the loose earth is shaken off, they are then washed and dried in the sun, or where there is not sufficient solar heat for the purpose, in stores heated by stoves or kilns. The epidermis, or outer skin of the roots, is sometimes removed by threshing them with flails, or by mechanical means. When thoroughly dry, the roots become very brittle, and are easily ground by mills with vertical stones—the powder being sifted so as to ensure it being equally fine. The powder is placed in casks, and improves for two years after grinding, but if kept longer it begins to deteriorate. The fresh roots yield about one quarter their weight of powdered madder.

The colouring principle of madder is called alizarin, $C_{14}H_8O_4$.[1] Powdered madder mixed with eight parts water, and kept for three days at a temperature of 80° F., ferments —the sugar of the root becoming alcohol. There is also obtained about 60 per cent of a superior colouring matter, *fleurs de garance*. Half a ton of madder yields about seven gallons of alcohol.

Madder is used in dyeing turkey-red, and giving lilac, purple, and pink colours to cotton. It is also used in bleaching. The colouring matter contained in fresh roots is yellow, in dry roots red. The bones of animals fed on madder become tinged with red.

From 1880 to 1884 the average price of fine peeled Dutch madder was 65.40 francs, and unpeeled 49.52 francs per fifty kilogrammes. In Holland the decadence was caused by the discovery of the aniline dyes, the gross adulteration of madder practised, and the profit attached to grazing and beet cultivation. Owing to agriculture not paying of late years, farmers are again turning their attention to madder.

In 1884 the United Kingdom imported 23,208 hundredweights of madder, madder-root, garancine, and munjeet.

[1] See Chemistry of Common Life, p. 493.

SAFFLOWER, CARTHAMINE, BASTARD SAFFRON
(*Carthamus tinctorius*).

Nat. Ord. COMPOSITÆ.

Although the use of this plant as a dye-stuff has been known to the Egyptians and East Indians for several thousand years, it has never been found growing wild, and its native country is unknown. It is one of those plants which appear to have been cultivated by man as far back as records go. It was used by the Egyptians for dyeing their mummy-cloths. The flowers are used as a red or yellow dye. It is extensively cultivated in India, China, Egypt, France, Spain, and other parts of the south of Europe.

Safflower is an annual plant, with a straight stiff whitish stem, which branches towards the top. It resembles a thistle in appearance. The leaves are oval and sharp-pointed, with small spines at the edges. The flower-heads grow at the ends of branches, and consist of numerous florets. The fruits are about the size of barleycorns. The plant grows to a height of two or three feet.

In Europe the seed is sown either broadcast, or in drills two feet apart, during the first half of spring. In a month's time the plants appear, and after another month they are hoed, weeded, and thinned—a distance of six inches being left between the plants in the rows. Before they flower the plants are again weeded; but it is important to keep the land clean, and the number of weedings must be regulated accordingly. Whenever the florets which form the flower-heads or compound flowers begin to open, the head is picked. The colour is very evanescent, and much would be lost if the heads were left till fully blown. The gathered flowers are dried in the shade or in kilns. The flowers must be gathered in dry weather.

There are two colouring matters contained in the flowers. The first, which is of little or no value, yields only dull shades of yellow, but is soluble in water. The second, carthamic

acid, is insoluble in water, but soluble in alcohol and alkalies, and is a very valuable red dye. These matters are easily separated. The flowers are tied in a sack and laid in a trough of gently flowing water, where they are trodden by the foot till there is no longer any yellow tinge visible in the water. The flowers are then pressed into little cakes, known in commerce as "stripped safflower."

The extraction of the carthamic acid, or red dye, is effected by macerating the stripped safflower in water, to which is added fifteen pounds crystallised carbonate of soda for one hundred pounds of safflower. The flowers are thus steeped for two hours till they have parted with their carthamic acid, which is held in solution in the water as carthamate of soda. The liquor is then run off, and may be used immediately as a dye by adding citric acid; or the carthamic acid may be precipitated by adding tartaric acid gradually, to prevent effervescence, the result being a bright-red powder. This powder, when mixed with water, is sold as "safflower extract." In either form, the dye is used to impart red, orange, rose, or flesh tints to satin and silk. The red powder, mixed with finely powdered or burnt talc, is sold as "rouge," used to heighten the colour of the complexion. For dyeing purposes, the colours obtained from safflower are not very permanent, and are inferior to the dyes obtained from coal-tar.

If only the petals of the flowers are plucked for the above purposes, there is still the seed-crop to yield a further return some three weeks later. The seeds, when subjected to pressure, yield twenty-five per cent of a transparent pale-yellow oil, sometimes called "curdee oil." This oil is excellent for table purposes. It burns well, and is a good drying oil. It is said to form the "macassar oil" which obtained such celebrity for toilet use. The seeds are most fattening food for poultry, and the oilcake good food for cattle. The stems of the plants may be burned for the sake of the potash they contain. The value of good Bengal safflowers is about £4 to £5, 5s. per hundredweight.

LIST OF THE PRINCIPAL WORKS

WHICH HAVE SUPPLIED INFORMATION FOR THE PRESENT VOLUME.

Handbook of Meteorology. Buchan.
Physical Geography. Page.
Cours d'Arboriculture, Les Vignobles. Du Breuil.
Cours d'Arboriculture, Arbres et Arbrisseaux. Du Breuil.
Encyclopædia of the Industrial Arts. Spon.
Encyclopædia Britannica.
Chambers's Encyclopædia.
American Encyclopædia. Ripley and Dana.
Johnson's Cyclopædia.
Consular Reports of the United States.
Reports of Chief Signal Officer of the United States.
Reports of Commissioner of Agriculture for the United States.
Pharmacographia. Fluckiger and Hanbury.
The Book of the Farm. Stephens.
Physiology at the Farm. Seller and Stephens.
Tropical Agriculture. Simmonds.
Universal Geography.
Pharmaceutical Journal.
Select Extra-tropical Plants. Von Mueller.
Class-Book of Botany. Balfour.
Treasury of Botany.
Vegetable Kingdom. Rhind.
Vegetation of Europe. A. Henfrey.
Physical Atlas. Keith Johnston.
Introduction of the Orange into New South Wales. G. Bennett, M.D.
Cyclopædia of Agriculture. Morton.
Botanical Geography. Mayen.
Profitable Plants. Archer.

Lectures on Climate in regard to Vegetable Life. C. Daubeny.
Cosmos. Von Humboldt.
Ionian Islands. J. Davy, M.D.
Materia Medica. Pereira.
Materia Medica. Royle.
Murray's Handbooks for Spain, Portugal, &c.
Murier et Vers à Soie. A. Gobin.
L'Olivier. J. Renaud.
Orange Culture in Florida. Moore.
Chemistry of Common Life. Johnston.
A Treatise on the Culture of the Orange in Florida. J. Davy, M.D.
Elements of Agricultural Chemistry. Johnston.
Statistical Abstract for Foreign Countries, &c.
Zeitschrift der Osterreichischen Gesellschaft für Meteorologie. J. Hann.
Condition of Climatological Observations over the Globe. R. H. Scott.
Die Temperatur-Verhältnisse des Russischen Reiches. H. Wild.
Report on the Meteorology of India in 1883. H. F. Blandford.
Etc. etc.

APPENDIX

TABLES OF MEAN TEMPERATURES

NORTHERN HEMISPHERE.

Country and Station.	Altitude.	Latitude.	Mean Temperatures. Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Rainfall.	Days on which Rain fell.	Years of observation.
Portugal—	Ft.	° ′	°	°	°	°	°	°	°	°	°	°	°	°	°	In.		
Oporto	328	41 8	50.2	52.0	53.4	59.7	63.0	69.4	69.8	70.3	67.1	61.2	55.2	50.9	60.1	54.4	162	8
Lisbon	313	38 43	50.5	51.5	54.4	58.3	61.9	67.3	70.1	71.0	67.9	62.3	56.4	50.4	60.1	28.7	112	20
Spain—																		
Oviedo	738	43 22	43.5	45.1	49.8	53.6	57.0	62.2	66.0	65.4	61.7	56.1	49.1	44.4	54.5	27.3	145.9	12
Bilbao	52	43 17	46.4	49.8	50.5	57.9	61.8	65.3	70.5	69.3	66.7	59.5	50.5	48.0	58.0	47.3	..	7
Barcelona	69	41 22	47.7	50.8	53.2	57.5	62.4	70.4	76.6	78.3	72.1	65.3	54.6	47.8	61.4	17.0	..	..
Madrid	2149	40 25	40.8	42.4	46.8	54.9	61.0	69.0	76.1	74.8	66.0	56.4	46.8	41.0	56.3	14.9	84.9	10
Valencia	59	39 21	50.6	54.6	56.1	61.5	63.8	71.2	73.2	79.5	73.7	67.2	57.9	50.6	63.3	13.2	..	..
Alicante	13	38 23	51.2	54.1	55.8	62.6	65.1	71.6	77.4	78.8	74.4	67.2	58.2	51.4	63.9	14.2	..	..
Murcia	138	38 0	48.7	51.8	54.3	60.3	65.8	72.9	79.0	77.7	72.1	64.4	55.0	49.8	62.6	14.1	63.2	9
Seville	98	37 24	51.8	55.6	59.7	63.5	69.6	77.0	85.6	81.5	79.7	69.4	60.0	52.0	67.1	22.3	..	..
Malaga	73	36 45	55.2	57.2	59.2	64 4	68.2	76.2	80.8	81.0	76.1	69.2	60.6	55.2	66.9	23.4	..	..
San Fernando	92	36 28	52.7	54.0	56.4	61.3	64.4	70.7	74.8	76.1	72.3	66.0	59.2	53.8	63.5	29.7	78.6	23
Tarifa	46	36 2	52.8	54.3	56.4	60.8	63.6	69.8	73.4	74.3	70.8	64.8	58.2	55.4	62.8	24.4	71.6	23
Majorca—																		
Palma	66	39 37	51.6	52.8	55.6	60.3	64.8	73.3	78.8	80.6	75.2	67.8	59.0	52.2	64.3	13.9	..	5
France—																		
Paris	150	48 50	35.4	39.5	43.9	49.7	58.0	62.7	65.6	65.3	60.1	52.2	44.1	38.5	51.3	23.6	188	39
Brest	216	48 23	44.0	45.3	46.0	52.0	55.8	60.4	64.2	63.9	60.8	54.1	46.9	43.3	53.0	35.5	..	10
Dijon	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Macon	680	46 18	31.3	39.7	47.3	49.1	55.9	62.6	65.3	67.9	59.9	48.1	42.4	33.7	50.2	25.4	123	3 y. 9 m.
Lyons	981	45 45	36.3	40.1	44.2	53.2	60.6	65.8	70.2	68.2	63.0	53.0	42.3	36.6	52.7	25.7	..	16
Bordeaux	243	44 50	41.0	45.0	51.3	56.0	60.8	66.8	73.1	73.1	67.1	58.1	48.4	43.2	57.0	..	..	10
Grenoble	726	45 11	31.0	38.8	47.3	50.7	57.2	63.5	68.0	67.1	60.2	50.9	41.3	32.2	50.6	35.7	130.8	5
Avignon	73	43 57	38.8	45.5	51.4	55.3	60.8	68.0	72.8	72.6	65.1	56.6	47.7	40.4	56.2	25.4	74	5
Nice	66	43 42	44.6	47.1	50.7	55.8	59.7	67.4	72.3	71.6	63.5	58.8	50.4	44.4	57.5	28.0	115	3 y. 7 m.
Marseilles	250	43 17	43.0	46.9	51.0	55.6	60.6	67.2	72.0	72.1	65.3	58.6	50.0	44.2	57.2	20.2	84.8	5
Montpellier	118	43 36	38.7	41.9	48.5	57.0	64.7	71.6	75.6	73.0	66.9	57.4	47.8	39.6	56.9	33.7	57.3	25
Pau	..	43 18	43.7	46.5	52.3	59.4	62.3	69.0	73.0	73.8	68.9	61.0	50.1	44.9	58.7	47.9	140	10
Perpignan	105	42 42	41.9	42.5	52.2	56.0	65.3	70.7	77.9	76.5	65.5	65.3	52.7	50.0	59.7	..	..	6

CORSICA—																	
Ajaccio . . .	60	41 55	49.5	51.8	53.6	57 7	62.4	70.3	75.7	77.9	71.8	64.2	56.3	50.7	61.8	..	60.3	4
SARDINIA—																	
Cagliari . .	115	39 13	48.47	51.6	50.6	58.2	65.7	70.7	76.2	77.6	71.0	66.5	58.6	53.0	62.3	..	..	3
ITALY—																	
Milan . . .	483	45 28	33.2	38.3	45 8	54.6	64.0	70.6	74.7	73.5	66.4	56.9	47.0	36.5	55.1	..	..	59
Venice . . .	20	45 26	35.2	39.0	46.1	54.7	63.3	70.3	75.0	73.7	66.2	56.6	44.6	39.9	55.4	..	..	7
Florence . .	239	43 47	41.2	44.5	50.5	59.6	65.4	71.1	76.9	75.9	69.1	60.4	50.3	45.5	59.2	..	..	12
Ancona . .	83	43 38	42.4	45.5	50.4	56.8	67.2	73.2	80.1	77.5	72.6	62.4	52.7	45.5	60.5	28.6	94.8	..
Rome . . .	100	41 54	44.8	47.8	50.7	56.8	65.1	71.6	77.4	75.6	70.0	60.9	52.0	46.2	59.8	29.2	95	15
Naples . . .	495	40 52	47.1	48.4	51.4	57.4	64.2	70.7	75.7	75.9	71.2	63.0	54.1	48.9	60.7	32.2	107.2	9
SICILY—																	
Palermo . .	..	38 7	51.4	51.3	54.0	58.3	64.8	71.1	75.7	76.3	72.6	67.0	59.1	54.7	63.0	..	..	39
Messina . .	..	38 11	54.2	54.2	56.6	60.5	67.2	73.8	78.4	79.0	75.5	69.4	62.6	56.4	65.7	26	64	5
MALTA—																	
Valetta . . .	70	35 53	56.4	55.4	57.4	60.6	67.4	73.0	78.2	79.2	75.6	70.8	63.1	57.9	66.2	20.1	..	10
GREECE—																	
Athens . . .	334	37 58	46.8	48.0	52.3	59.0	67.9	75.9	80.6	80.0	74.1	65.7	57.2	49.8	63.1	..	..	24
Corfu . . .	99	39 38	50.4	50.5	53.4	60.0	67.1	74.1	79.3	78.8	73.4	67.6	59.4	52.8	63.9	53.5	98.8	10
TURKEY—																	
Constantinople .	..	41 0	40.2	40.6	46.0	50.5	58.8	67.1	71.8	72.5	66.9	60.4	51.6	43.8	55.8	41.3	..	13
RUSSIA—																	
Yalta . . .	131	44 30	40.1	38.4	43.3	50.9	61.0	69.6	74.0	75.5	65.6	58.1	52.3	44.4	56.1	..	..	7
Astrachan . .	−66	46 21	19.9	20.8	31.4	49.0	64.0	72.9	77.8	74.4	63.7	51.0	36.8	26.1	48.9	..	..	40
Kutais . . .	459	42 16	40.2	42.6	47.9	56.6	65.6	69.4	73.0	75.8	68.0	62.0	54.8	43.8	58.3	..	..	13
Tiflis . . .	1411	41 43	32.7	35.4	43.5	53.1	63.5	69.8	75.7	75.6	66.7	57.2	45.6	36.5	54.6	..	..	14
Lenkoran . .	−66	38 46	37.1	40.8	45.5	53.6	65 7	73.0	77.7	77.0	69.4	62.1	51.2	41.7	57.9	..	..	9
TURKEY IN ASIA (Asia Minor)—																	
Smyrna . .	..	38 26	50.6	51.1	57.3	61.6	71 2	78.1	82.7	82.3	76.9	69.1	60.4	53.6	59.6	24.0	68.0	10
Erzerum . .	..	39 57	28.2	36.0	48.2	64.6	68.2	83 3	89.1	90.1	77.7	64.9	43.7	30.2	60.3	..	..	2¼
Beirout . .	98	33 54	53.8	52.3	58.8	60.8	68.0	73.4	77.0	77.5	75.2	70.8	64.2	57.0	65.8	37.2	..	..
Jerusalem . .	2500	31 47	47.2	48.8	58.4	59.8	67.8	73.0	74.8	76.2	72.2	71.8	61.0	49.9	63.4	16.28	50	3 y. 4 m.
Bagdad . .	..	33 21	52.0	53.1	64.2	72.0	86.7	90.5	94.5	93.6	85.8	75.6	62.1	52.7	73.5	..	..	4
EGYPT—																	
Alexandria . .	62	31 11	56.1	58.4	60.8	66.0	71.6	76.2	78.0	80.6	77.7	75.4	69.3	60.6	69.2	10.0	59.3	..
Cairo . . .	96	29 59	55.8	56.3	64.6	70.5	79.7	83.4	85.4	83.8	79.1	74.4	64.6	59.2	71.4	..	..	10
Kosseir . .	..	26 5	64.9	66.6	71.1	75.9	79.1	83.8	84.6	84.9	83.8	79.2	74.1	68.0	76.3	..	..	2
CYPRUS—																	
Larnaca . .	..	34 54	52.5	50.4	57.0	63.3	71.6	81.0	84.2	84.9	81.6	73.0	60.6	54.5	67.8	12.7	54.3	..

NORTHERN HEMISPHERE—*Continued.*

Country and Station.	Altitude.	Latitude.	Mean Temperatures. Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Rainfall.	Days on which Rain fell.	Years of observation.
Algeria—	Ft.	° ′	°	°	°	°	°	°	°	°	°	°	°	°	°	In.		
Algiers	70	36 47	53.8	54.6	57.0	61.3	66.2	72.1	75.9	77.0	74.1	67.5	60.4	54.9	64.5	29.0	79	20
Oran	174	35 42	49.8	52.2	54.9	59.4	64.8	70.5	75.7	76.2	71.1	64.8	58.1	51.8	62.4	..	..	20
Aumale	2969	36 10	43.0	44 6	48.0	54 0	63.1	72.6	79.2	80.4	70.8	60.0	50.9	43.5	59.2	..	..	10
Biskra	410	34 51	50.2	54.3	57.0	66.0	75.9	84.4	89.8	88.2	80.2	68.0	57.7	51.4	68.5	..	..	10
Marocco—																		
Mogador	54	31 30	61.5	62.6	64.8	67.5	68.9	71.8	72.3	71.6	71.2	69.6	66.0	62 1	67.5	..	..	6
Canary Islands—																		
Teneriffe	..	28 12	55.8	55.4	56.3	59.4	62.4	66.0	69.3	75.6	73.7	68.7	61.8	57.7	63.5	..	..	5
Madeira—																		
Funchal	82	32 44	61.2	61.0	60.8	61.8	64.9	68.5	70.3	72.6	72.3	69.4	65.1	62.1	65.8	21	73	6
Azores—																		
Terceira	..	38 36	56.3	56.7	56.7	59.4	61.7	66.4	70.7	70.2	69.8	65.4	61.8	58.1	62.7	..	..	6
Fayal	..	39 35	57.0	55.0	57.4	58.6	61.5	64.4	70.8	72.3	67.6	64.9	60.6	57.2	62.2	29.9	..	2
Turkestan—																		
Yarkand	..	38 20	29.3	41.4	55.2	76.6	82.8	89.4	95.4	88.2	78.6	66.6	43.5	30.0	64.7	..	..	1
Persia—																		
Bushire	25	28 59	57.4	57.0	62.7	71.7	81.2	84 2	88.1	88.9	85.2	77.8	69.1	60.7	73.7	12.87	..	6–7
Arabia—																		
Muscat	..	23 37	68.0	70.2	72.9	85.1	92.0	93.2	93.4	86.7	87.0	80.1	76.1	70.8	81.4	..	..	3
Beluchistan—																		
Quetta	5500	30 11	40.5	40.5	50.6	58.6	67.7	74.3	76.8	75.2	66.8	56.4	45.3	41.3	57.8	8.24	..	5–6
Cashmere—																		
Leh	11,538	34 10	17.1	19.9	31.1	41.1	46.9	56.2	61.6	59.6	52.0	39.6	30.3	23.1	39.9	2.72	..	8–13
India—Punjab—																		
Peshawar	1110	34 2	50.3	52.3	62.5	71.3	81.6	89.5	88.7	87.1	81.3	71.3	58.2	50.9	70.4	13.30	..	7–8
Dera Ismail Khan	572	32 0	52.1	56.4	66.4	77.3	87.0	93.1	91.2	89.5	85.8	75.0	61.6	53.7	74.1	8.46	..	15–17
Mooltan	420	31 10	54.3	58.3	70.4	79.9	88.7	94.4	91.5	89.0	86.5	77.0	66.0	56.3	76.0	7.07	..	13–15
Simla	7020	31 6	40.4	41.4	49.4	58.8	64.1	67.4	64.2	63.0	61.3	55.9	48.6	45.1	55.0	71.24	..	9–12
Delhi	717	28 40	58.3	62.3	74.4	84.6	89.6	93.7	87.0	86.7	84.7	79.1	68.4	60.2	77.4	26.92	..	8–9
N.-W. Provinces—																		
Agra	555	27 10	60.0	65.3	76 4	87.9	93.7	94.6	87.0	85.5	84.3	79.6	69.7	61.9	78.8	25.66	..	20–21

OUDH—																		
Lucknow . .	369	26 50	60.7	66.2	76.8	87.4	91.8	92.0	86.3	85.5	84.7	79.0	68.9	61.1	78.4	36.59	..	17–18
Allahabad . .	306	25 26	60.6	65.7	78.0	87.6	92.1	91.2	85.1	83.9	83.1	77.9	67.9	60.6	77.8	37.68	..	16–18
ASSAM—																		
Silchar . . .	104	24 49	63.6	67.3	73.3	78.0	79.6	81.7	82.3	81.9	81.7	79.7	73.1	65.8	75.7	118.85	..	14–15
BENGAL—																		
Darjeeling . .	7421	27 3	39.4	41.2	47.8	53.8	55.9	59.6	60.9	60.7	58.5	54.5	47.9	41.9	51.8	120.85	..	15–16
Berhampore . .	66	24 6	64.5	69.2	78.1	85.3	85 0	84.2	83.2	82.8	83.0	80.5	73.0	65.6	77.9	55.71	..	16
Calcutta . .	21	22 32	65.1	70.9	79.0	84.4	84.8	84.5	83.0	82.4	82.4	80.1	72.5	64.9	77.8	60.0	..	6–7
CENT. PROVINCES—																		
Nagpur . .	1025	21 9	68.6	73.8	81.9	88.8	93.1	85.7	79.1	79.3	79.1	77.2	70.7	67.1	78.7	44.51	..	14–15
BOMBAY—																		
Hyderabad . .	134	25 25	63.3	66.1	78.3	86.1	91.2	90.6	87.9	85.4	85.7	82.8	71.3	63.2	79.3	8.21	..	5–7
Bombay . .	37	18 54	73.9	75.4	79.0	82.5	85.0	83.1	80.9	80.1	80.0	81.0	78.9	76.0	79.7	74.08	..	37
MADRAS—																		
Madras . .	22	13 4	75.8	77.4	81.0	85.1	87.4	87.7	85.5	84.5	84.2	81.3	78.4	76.1	82.0	48.89	..	24
Outacamund .	7361	11 23	54.0	56.0	60.0	61.0	61.0	57.0	63.0	63.0	62.0	56.0	54.0	53.0	58.3	60.0	..	..
Dodabetta . .	8636	11 32	50.0	52.0	55.0	56.1	57.4	52.2	51.6	52.3	51.4	52.3	51.0	50.4	52.6	..	..	3
Wellington . .	6200	10 22	55.3	58.3	62.7	65.1	65.6	63.4	62.5	62.4	61.9	60.6	58.3	55.6	61.0	45.37	..	10–12
Madura . .	447	9 55	77.2	79.2	82.8	85.7	85.7	85.0	84.3	83.4	83.0	80.7	78.8	77.1	81.9	35.33	..	14
Cochin . . .	11	9 58	78.8	80.1	82.5	83.8	81.8	78.3	77.3	77.7	78.1	78.8	79.4	78.8	79.6	115.02	..	12–13
Mercara . .	3694	12 26	64.6	67.7	70.3	71.6	70.5	65.2	63.7	64.5	64.3	66.1	65.7	64.1	66.5	128.21	..	3–4
CEYLON—																		
Colombo . .	40	6 56	79.5	80.5	82.0	83.2	82.9	81.6	81.1	80.6	81.4	80.8	80.3	79.9	81.2	87.74	..	14–15
Kandy . . .	1696	7 18	74.1	76.1	78.7	79.1	79.0	76.4	75.7	75.8	75.9	75.9	75.4	74.5	76.4	84.81	..	13–14
Newera Eliya .	6240	6 59	57.5	57.4	59.0	60.1	61.2	59.3	58.5	58.8	58.8	59.0	58.7	58.0	58.9	101.80	..	12–14
CHINA—																		
Hongkong . .	43	22 16	61.1	62.3	63.0	70.9	79.3	81.7	82.7	82.0	81.2	73.1	70.7	66.0	72.8	77.87	..	5
Kelung . .	33	25 20	57.6	58.2	61.3	65.8	73.9	81.3	82.8	81.6	79.7	73.6	66.0	62.6	70.3	..	..	2
Shang-hai . .	..	31 13	38.3	39.9	47.1	55.4	65.4	72.9	82.6	80.6	73.4	63.1	51.3	42.3	59.3	..	..	12
Taku . . .	33	38 59	23.4	28.6	39 6	54.3	66.2	75.7	79.0	79.8	69.0	54.5	39.0	28.4	53.1	..	..	3
Pekin . . .	131	39 57	23.9	29.1	41.2	56.6	67.8	75.7	78.9	75.5	68.0	54.6	38.8	27.9	53.2	..	..	26
Si-wan-tse . .	3904	40 59	2.5	11.8	27.1	38.1	52.8	63.3	65.3	65.4	52.8	37.4	19.4	10.2	3.71	..	..	11
JAPAN—																		
Nagasaki . .	189	32 44	41.4	43.0	48.5	57.7	65.1	71.1	79.3	81.1	75.6	64.6	54.5	45.3	60.6	..	..	10
Tokio . . .	63	35 40	36.1	37.6	44.6	54.0	62.8	68.7	77.0	77.9	70.8	58.5	48.0	40.8	56.4	..	..	7
Yokohama . .	..	35 46	39.2	42.2	46.0	54.7	64.6	71.6	78.7	79.4	70.2	59.8	49.5	47.5	57.7	71.17	97.5	9
Niigata . .	32	37 55	32.0	32.2	39.9	52.0	60.8	68.4	77.5	79.8	72.6	62.8	50.5	38.1	55.5	..	..	3
Hakodadi . .	131	41 46	27.4	29.5	35.1	44.2	52.5	59.2	66.6	70.5	64.2	53.1	41.7	32.2	48.0	..	..	10

NORTHERN HEMISPHERE—*Continued.*

Country.	Station.	Altitude.	Latitude.	Mean Temperatures Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Rainfall.
		Ft.	° ′	°	°	°	°	°	°	°	°	°	°	°	°	°	In.
United States	Norfolk (Vir.)	30	36 51	40.4	43.4	47.7	56.6	68.7	75.6	80.3	76.9	70.9	62.2	49 8	42.4	58.9	52.7
"	Wilmington (N. C.)	52	34 11	47.3	50.2	54.5	61.3	70.1	76.4	79.5	77.8	72.7	64.7	54.6	47.9	62.9	58.5
"	Charleston (S. C.)	52	32 45	50.6	53.2	57.6	64.5	73.1	80.7	83.3	81.7	76.0	68.0	57.5	51.4	65.9	62.6
"	Savanna (Ga.)	87	32 5	52.0	54.7	59.7	66.3	73.9	81.2	83.2	81.8	75.3	67.8	69.2	52.6	66.8	54.6
"	Jacksonville (Fla.)	43	30 24	56.0	58.6	63.1	69.5	74.6	81.3	83.1	81.7	77.2	70.6	62.2	56.2	69.2	55.9
"	Punta Rassa "	13	26 36	65.0	65.9	69.2	71.8	76.1	80.5	81.9	81.5	80.0	75.9	70.8	65.2	73.6	44.4
"	Montgomery (Ala.)	219	32 22	49.1	53.3	58.0	64.9	75.8	80.8	83.1	80.0	74.7	66.2	55.3	49.5	65.5	55.2
"	Vicksburg (Miss.)	244	32 23	48.1	53.3	58.8	66.9	75.9	80.8	82.4	80.1	74 0	66.2	55 4	50.5	65.8	59.7
"	Nashville (Tenn.)	507	36 11	38.8	44.0	49.5	56.0	73.5	77.9	81.5	78.6	68.9	62.1	48.1	41.3	59.9	51.4
"	Little Rock (Ark.)	298	34 40	42.5	48.0	54.1	62.7	73.7	79.2	81.1	76.3	69.9	63.1	51.4	46.1	62.0	56.3
"	Louisville (Ken.)	530	38 18	34.6	39.4	44.8	55.8	71.1	74.7	80.6	76.9	66.8	59.4	45.1	38.0	56.7	49.0
"	Galveston (Tex.)	40	29 18	52.8	57.5	63.8	69.3	77.5	82.6	84.0	82.6	78.6	72.1	61.9	56.4	69.6	51.6
"	Fort Concho "	1900	31 22	36.5	48.4	58.1	65.0	74.3	85.2	82.7	65.4	71.0	65.0	51.6	46.0	62.0	31.4
"	La Mesilla (New Mx.)	4124	32 17	37.7	47.6	50.5	63.8	70.0	79.6	77.9	75.1	69.3	58.3	44.2	42.2	59.6	7.4
"	Yuma (Ariz.)	141	32 44	56.2	61.0	64.3	74.0	79.6	89.5	89.6	90.0	83.2	71.2	63.4	55.9	72.2	2.3
"	San Diego (Ca.)	67	32 45	53.4	54.6	56.1	57.8	61.2	64.7	67.7	68.9	66.9	63.3	58.7	54.8	60.3	10.0
"	Los Angeles "	371	34 03	52.1	53.5	55.3	57.8	62.7	65.6	64.2	66.4	64.5	62.0	57.7	54.7	59.8	18.9
"	Visalia "	348	36 20	48.3	53.7	54.8	63.4	68.5	71.9	78.6	76.4	72.3	61.1	46.9	49.9	61.9	10.4
"	San Francisco "	60	37 48	51.1	53.1	54.0	54.8	56.5	59.4	58.3	58.2	59.5	59.5	56.9	51.7	55.8	23.9
"	Sacramento "	65	38 35	50.5	54.4	54.4	59.2	63.6	70.0	75.0	73.2	70.8	62.8	53.5	46.8	60.1	25.9
"	Red Bluff "	326	40 10	45.3	48.3	54.3	58.7	69.3	72.8	..	77.4	74.7	65.3	51.5	46.5	63.0	36.3
"	Tucson (Ariz.)	2404	32 14	48.7	50.9	58.8	67.1	76.6	85.5	86.0	83.6	80.8	69.9	56.7	52.3	68.0	12.4
"	Salt Lake City (Utah)	4348	41 10	28.7	31.5	39.8	48.2	57.4	69.1	76.7	75.0	64.1	51.9	39.8	29.9	51.8	17.5
"	Dodge City	2517	37 39	26.5	33.3	42.1	52.9	67.2	76.4	78.9	76.5	66.6	55.0	38.5	31.4	53.4	17.5
"	Portland (Oreg.)	67	45 30	39.3	43.7	47.6	51.9	57.1	63.1	68.3	66.5	61 1	54.0	46.2	41.8	52.9	53.2
"	Prescott "	5389	34 29	36.0	39.2	43.3	52.4	66.3	72.1	74.6	73.3	69.9	53.9	40.5	31.4	51.9	12 9
"	Denver (Col.)	5294	39 45	27.5	31.7	39.7	46.4	61.1	70.3	73.1	70.9	61.0	49.7	36.9	30.2	49.1	14.7
"	Alpena (Mich.)	609	45 5	18.5	19.1	24.4	36.2	53.7	59.5	68.2	66.0	57.5	48.8	32.0	23.9	42.1	36.7
"	Eastport	61	44 55	19.8	2.29	28.7	38.0	47.5	54.0	61.1	60.3	56.3	49.2	35.6	25.3	41.8	47.6
Mexico	City of Mexico	7391	19 26	55.2	57.4	61.1	67.8	67.5	66.0	64.0	62 1	61.5	59.7	57.6	54.3	60.1	..
Bermudas	Bermuda	151	32 17	63.7	63.6	62.6	66.6	71.7	77.2	80.9	82.5	79.6	74.5	70.5	66.0	71.5	52.0

SOUTHERN HEMISPHERE.

Country and Station.	Altitude.	Latitude.	Mean Temperatures. Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Rainfall.	Days on which Rain fell.	Years of observation.
Peru—	Ft.	° ′	°	°	°	°	°	°	°	°	°	°	°	°	°	In.		
Arica . . .	..	18 25	71.6	71.4	70.3	68.0	66.0	64.8	63.6	63.1	63.0	66.0	69.0	71.6	67.3	..	8	2
Chili—																		
Copiapo . .	1296	27 22	70.3	70.8	68.7	64.0	59.7	56.6	57.4	56.4	61.3	64.9	67.4	70.7	64.0	0.3	..	2
Serena . . .	59	29 55	65.3	66.0	62.6	60.4	56.4	53.6	53.4	55.8	58.2	59.9	61.5	63.6	59.7	..	..	..
Valparaiso . .	36	33 2	63.0	63.1	60.6	58.2	55.5	53.6	53.1	52.5	54.0	56.7	59.0	62.9	57.7	13.77	..	1
Santiago . .	1867	33 26	68.2	65.6	61.6	54.9	49 2	45.5	44.9	47.3	51.8	56.3	62.4	66.8	56.2	10.86	..	10
Valdivia . .	43	39 49	61.5	60.8	57.2	52.7	49.6	46.2	45.0	46.2	48.7	52.3	55.9	58.8	52.0	106.0	131	24
Brazil—																		
Rio de Janeiro .	209	22 54	80.4	80.4	77.9	75.4	70.7	68.5	67.1	70.0	70.5	73.2	74.4	77.2	73.8	47.6	88.1	6½
Santa Cruz . .	..	29 35	76.5	77.5	73.6	63.0	59.0	57.9	53 8	59.9	62.6	70.0	71.2	74.4	66.6	..	..	..
Paraguay—																		
Asuncion . .	98	25 16	80.1	82.9	81.5	73.6	68.0	60.0	70.0	73.9	78.0	82.6	82.0	80.8	76.1	82.0	..	..
Uruguay—																		
Monte Video .	..	34 54	73.0	72.1	68.7	64.0	57.6	53.1	51.8	51.6	56.4	61.2	65.4	70.3	62.1	43.54	36.0	10
Argentine Repub.—																		
Tucuman . .	..	26 50	73.8	74.1	70.5	67.8	57.5	53.0	53.9	60.6	66.4	66.9	74.0	76.6	66.3	41.73	..	..
Pilciao . . .	..	27 20	83.0	76.6	71.4	64.9	58.5	50.4	47.3	56.3	66.8	74.8	76.4	83.0	67.5	..	..	..
Cordoba . .	..	31 0	73.0	70.3	65.3	58.3	53.4	49.7	47.1	53.7	60.1	62.2	68.3	72.5	61.2	30.5	..	..
Salta . . .	..	32 12	69.0	70.0	65.0	61.8	55.0	59.1	54.6	58.4	64.0	64.5	68.0	69.9	63.3	..	..	..
Buenos Ayres .	82	34 39	75.5	74.1	70.2	62.4	56.6	52.0	49.6	53.1	56.6	62.3	68.2	73.4	62.8	33.2	..	14
Bahia Blanca .	63	39 25	75.3	73.2	65.8	59.9	52.8	47.6	46.5	50.3	54.6	63.6	66.5	72.5	60.7	17.7	..	15
Africa (South)— .																		
Capetown . .	37	33 56	70.3	69.7	67.1	62.6	58.4	55.9	55.2	56.1	58.0	61.1	64.3	68.3	62.2	24.1	..	10
Grahamstown .	1700	33 18	74.3	73.3	72.1	67.4	65.0	63.4	62.5	65.9	67.1	68.2	69.2	70.3	68.2	25.25	..	2
Durban . .	150	29 53	74.3	76.0	71.7	69.7	67.2	63.2	62.2	64.4	64.3	69.9	70.4	74.2	68.9	41.8	..	..
Pietermaritzburg .	2095	29 30	70.5	70.3	68.7	63.8	57.7	52.8	54.4	58.6	62.9	65.1	65.4	69.2	63.3	31.1	130	6
West. Australia—																		
Cossack . .	19	20 40	89.0	91.0	87.0	77.0	69.0	66.0	62.0	68.0	74.0	79.0	81.0	84.0	77.0	14.03	31	1
Perth . . .	47	31 57	76.0	76.0	72.0	66.0	60.0	56.0	55.0	56.0	60.0	64.0	69.0	71.0	65.0	32.7	..	10
Freemantle . .	..	32 4	71.0	71.0	67.2	63.1	60.6	56.1	56.8	55.9	58.8	61.3	64.9	68.4	62.9	32.9	100	..

SOUTHERN HEMISPHERE—*Continued.*

Country and Station.	Altitude.	Latitude.	Mean Temperatures. Jan.	Feb.	Mar	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Rainfall.	Days on which Rain fell.	Years of observa-tion.
	Ft.	° ′	°	°	°	°	°	°	°	°	°	°	°	°	°	In.		
South Australia—																		
Adelaide . .	..	34 53	73·7	73·8	70·1	64·6	58·2	54·4	51·5	53·7	56·9	62·5	66·5	71·4	63·1	21·0	114	10
Mount Gambier .	130	37 50	66·0	67·3	64·8	59·0	54·8	49·7	48·8	51·4	53·2	56·4	58·6	62·5	57·8	31·67	..	5
Port Augusta .	10	32 29	77·0	75 2	71·9	65·4	58·3	52·8	52·7	57·7	60·6	63·2	69·4	72·6	64·7	8·60	..	3 y. 9 m.
Alice Springs .	2100	23 38	85·4	82·5	79·0	69·7	61·3	52·4	53·8	60·3	65·1	57·5	80·4	84·3	70·3	12·83	..	4½
Port Darwin .	..	12 27	83·1	82·2	83·7	83·8	80·4	77·4	76·4	79·3	82·0	84·4	85·8	89·2	82·2	..	..	6
Victoria—																		
Melbourne . .	91	37 50	66·6	65·6	63·8	59·0	53·3	49·5	47·8	50·2	53·2	57·0	60·9	63·7	57·5	25·66	137	14
Portland . .	37	38 20	67·0	67·2	66·4	63·0	58·4	55·3	53·6	55·5	57·6	60·6	62·4	64·1	60·9	32·32	..	13
Ballarat . .	1438	37 34	63·7	62·7	60 9	54·7	49·0	45·4	42·5	45·8	47·7	52·7	57·7	60·8	53·6	26·26	..	12 (?)
Sandhurst . .	778	36 47	70·7	70·0	66·8	59·7	53·9	48·1	45·6	48·7	51·8	57·7	64·4	67·5	58·7	23·84	..	12 (?)
New South Wales—																		
Sydney . .	155	33 51	71·0	70·7	69·0	64·9	58·4	54·8	52·4	54·3	58·6	63·4	66·2	69·2	62·7	51·5	152	15
Paramatta . .	..	33 48	72·0	68·3	67·2	62·9	56·3	53·0	50·4	54·5	56·8	63·9	69·4	71·3	62·3	..	..	3 y. 10 m.
Newcastle . .	112	32 55	72·5	71·6	69·5	65·3	59·6	55·8	53·2	55·1	59·1	64·1	65·3	70·9	63·5	54·1	123	5
Port Macquarie .	53	31 25	72·8	72·8	70·1	65·8	60·3	56·9	54·0	56·1	59·8	63·8	67·2	71·3	64·2	63·2	139	5
Grafton . .	40	29 43	81·4	76·7	76·1	69·0	62·1	56·8	54 1	58 0	64·0	69·5	73·3	76·4	68·1	36·2	77 6	5½
Queensland—																		
Brisbane . .	110	27 27	78·6	77·3	75·9	71·3	65·6	60·1	59·7	62·8	67·5	71·6	76·5	78·4	70·4	49·6	128	10
Rockhampton .	50	20 25	80·6	79·9	76·1	73·9	67·6	61·3	61·5	65·4	70·7	74·7	80·3	81·1	72·5	32·2	83·2	4
Mackay . .	..	21 9	80·5	79·2	77·9	73·4	68·0	63·1	60 6	65·0	70·3	74·8	81·4	82·6	73·4	68·1	130	4
Cooktown . .	20	15 27	83·8	82·9	82·2	79·8	77·6	74 8	73·3	74·6	76·9	80·1	83·3	83·8	79·4	64·2	128	3
Tasmania—																		
Hobart . . .	190	42 53	62·7	62·1	60·0	55·3	50·6	47·0	46·0	48·5	51·1	54·4	57·6	61·2	54·7	22·71	139·8	30
New Zealand—																		
Mongonui . .	70	35 1	68·3	68·9	66·7	63·4	58·5	55·7	53·9	53·6	56·1	58·6	62·0	66·7	61·0	54·7	166	11 (?)
Auckland . .	258	36 50	67·8	67·9	65·6	62·4	57·2	53·3	52·2	52·3	54·8	57·6	61·2	65·6	59·8	43·8	189	16
Napier . . .	14	39 29	66·6	66·0	62·8	58·8	54·8	51·2	49·9	50·7	53·8	58·3	61·8	65·9	58·3	34·8	107	9
Wellington . .	140	41 16	62·9	62·7	62·3	57·1	53·0	49·0	47·8	48·0	51·2	53·9	56·9	61·1	55·5	51·8	158	16 (?)
Nelson . . .	18	41 16	64·5	64·0	60·4	57·0	51·1	47·6	46·3	47·6	51·2	54·7	58·2	62·1	55·3	61·8	89	13 (?)
Christchurch .	21	43 32	62·1	61·1	58·1	53·9	48·1	43·2	42·6	44·0	48·8	53·1	56·7	61·1	52·7	24·8	117	14 (?)
Dunedin . .	550	45 52	57·5	57·5	55·4	52·0	47·2	43·7	42·7	43·0	47·4	50·6	52·7	56·3	50·5	29·0	160	16

MISCELLANEOUS STATIONS.

Country and Station.	Altitude.	Latitude.	Mean Temperatures. Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Rainfall.	Days on which Rain fell.	Years of observation.
	Ft.	° ′	°	°	°	°	°	°	°	°	°	°	°	°	°	In.		
England—																		
Worthing	31	50 49 N.	39.6	41.3	42.9	48.9	53.2	59.1	62.3	62.5	58.9	52.5	44.2	41.1	50.5	..	..	20
Truro	43	50 16 N.	43.4	44.7	45.4	49.8	53.4	58.9	61.9	62.1	58.5	53.2	46.5	44.3	51.8	..	..	20
Belgium—																		
Brussels	187	50 51 N.	36.3	39.4	41.7	50.2	55.6	61.2	65.7	63.0	59.2	49.6	42.4	37.2	50.2	..	..	10
Prussia—																		
Berlin	160	52 30 N.	31.3	33.6	38.1	47.3	55.6	63.6	66.2	64.8	58.1	49.5	38.7	33.4	48.3	23.3	165.4	30
Cuba—																		
Havana	62	23 10 N.	72.0	72.3	74.4	77.5	80.1	82.0	82.0	82.4	81.0	78.8	75.0	73.0	77.5	46.2	109	3
Guatemala—																		
Guatemala	4854	14 38 N.	61.2	62.2	66.9	68.0	69.4	67.6	66.2	66.2	65.8	64.8	64.8	62.1	65.4	48.8	162	3
Mauritius—																		
Port Louis	..	20 10 S.	79.2	78.9	78.1	76.7	73.3	70.3	68.8	69.1	70.3	72.5	75.3	77.9	74.2	..	..	12–13
Manilla—																		
S. Anna	108	14 35 N.	75.4	76.8	78.4	80.8	82.4	81.5	80.2	80.4	79.7	78.8	77.5	75.7	79.0	86.5	143.4	4
Java—																		
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